PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT

# AN INTRODUCTION TO: THE LIFE HISTORIES OF *MYRIOPHYLLUM* SPECIES IN SOUTHWESTERN BRITISH COLUMBIA

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## SUMMARY

Several species of the genus Myriophyllum grow in nuisance proportions in parts of British Columbia. One, M. spicatum, is a major problem and is already the subject of extensive attempts at control. In order to be able to separate treatment effects from natural changes, and to identify the most effective time for treatments, it is necessary to understand the natural yearly growth cycle of the plants.

This report presents the results of a study on the Myriophyllum species of southwestern British Columbia over a period of 16 months. Each species was observed in at least one site, generally several times a month, for the duration of the study. At each visit water temperatures were measured and notes made on the condition of the plants. The presence or absence of turions, inflorescences, flowers and fruits, and the amount and vigour of vegetative growth were recorded. This information about the state of growth of each species was plotted along with water temperature and the photoperiod of the site, against time. We now know for each species what we could normally expect to find, on at least one site in the southwestern part of the province, at any given time of the year.

Based on their life cycles, the nine species of Myriophyllum found in B.C. fall into three main groups and two unique species. Group one contains M. exalbescens and M. verticillatum. They overwinter only as seeds or turions and have a single cycle of vegetative growth in a year. These are common, widespread, native species. The second group has no turions and overwinters as rhizomes or root crowns. They are introduced species with several cycles of vegetative growth in one year and are evergreen in mild coastal regions. The species are M. elatinoides, M. brasiliense and M. spicatum. Group three consists of M. hippuroides, M. heterophyllum and M. spicatum. These are all North Temperate species but do not form turions.

Under mild conditions they are evergreen but under more severe conditions die back to a root crown or caudex. They have several overlapping cycles of vegetative growth in a year. The two unique species are M. ussuriense and M. farwellii; both have turions but have different life cycles.

Photo-period and water temperature curves, especially in small ponds and lakes with no major snowmelt runoff in late spring, are closely correlated. Flowering generally peaks at or shortly after the longest day.

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# INTRODUCTION

Some work has been done on the yearly growth cycle of Myriophyllum spicatum L. in the Okanagan Valley, but no systematic observations on the ontogenetic cyles of any other species of Myriophyllum, anywhere else in British Columbia, have been carried out up to now. If any rational control program is to be carried out, and monitoring activities afterward are to separate treatment effects from natural changes, then it is necessary to understand the normal yearly cycle of growth and the responses of the plants to natural environmental variables. Knowledge of the normal growth cycle also allows one to choose treatment times and methods which may have maximum effect.

This report represents the first brief introductory study of the life-cycles of Myriophyllum species in southwestern British Columbia and should form the basis for determining what kinds of further more detailed studies are necessary and what parameters may be important. At the very least we now have a skeleton outline of the yearly cycle of growth for each species, in at least one locality for one year. We do not know if this is a typical yearly cycle or if the year chosen was in any way atypical for any species or site. We know for one yearly cycle how the plants overwinter, when they flower and fruit, when turions germinate and are formed, and the yearly cycle of vegetative growth types and changes. There are tentative correlations with some environmental parameters such as water temperature, water level and photo-periods.

The growing season in which observations were made, 1980, was, as are most, atypical in some respects and this is reflected in the particular cycle of events chronicled and the specific dates on which certain events happened. The long, cold, cloudy, late spring is indicated by the temperature profiles of several small ponds whose temperatures are generally direct functions of solar insolation. The high water levels in some lakes in mid-summer, which flooded flowers and prevented fruit formation, did not occur

in previous years since flower and fruit collections exist from these sites.

Table 1 identifies the sampling and observation sites and indicates which species grow there. Table 2 gives the sampling and observation dates for each site and the water temperature on that date. An X indicates that observations were made but no temperatures recorded. A figure for each species at each site shows a plot of daylength, sunrise to sunset, (continuous line) and a plot of temperature (connected sample points); bar graphs show periods of flowering, fruiting, turion presence for species that have turions, periods when the plants were exposed for M. ussuriense (Regel) Maxim., and periods when emergent inflorescences were present for those species that have emergent inflorescences. For each species at each site there is a descriptive discussion of the vegetative dynamics over the observation period. A map for each species shows the known distribution in British Columbia.

The sites were chosen on the basis of proximity to the Victoria office and ease of accessibility in all weather in order to make repetitive sampling as economical and efficient as possible. For 2 species the sites were the only known sites and since we necessarily had to visit these specific sites, sampling for other more widespread species was kept to the same general area.

TABLE 1

SITE IDENTIFICATION AND DESCRIPTION

| Site # | Site Description and Species of *Myriophyllum* Observed |
|---|---|
| 1 | The south end of Shawnigan Lake, both small bays where creeks of cold water enter the lake (48°40'). *Myriophyllum verticillatum* L. |
| 2 | The uppermost portion of the Cowichan river between the weir on the lake and the railroad bridge (48°50'). *Myriophyllum elatinoides* Gaud. |
| 3 | Inside Marble Bay, adjacent to the UVIC biological field station, towards the NE end of Cowichan Lake (48°50'). (*M. exalbescens* Fern. present in small amounts). *Myriophyllum verticillatum* L. |
| 4 | Echo Lake, west of Campbell River, in a bay on the west side of the lake under and around an old logging road trestle; access is through the logging camp (50°00'). *Myriophyllum farewellii* Morong. |
| 5 | Diver Lake, Nanaimo, access via Black Franks Road which leads to the public park and beach on the south side (49°10'). *Myriophyllum exalbescens* Fern. |
| 6 | Centennial Pond, Boundary Bay on the west side, in a public park; an artificial pond (49°00'). *Myriophyllum spicatum* L. |
| 7 | Pitt meadows roadside drainage ditches in a 'Ducks Unlimited' managed marsh. The site is at the last culvert crossing under the road before reaching the Grant Narrows boat launch site on Pitt Lake (49°20'). (*M. verticillatum* L. is uncommon here and *M. ussuriense* (Regel.) Maxim is present where mudbanks are exposed in August and September). *Myriophyllum hippuroides* Nutt. |
| 8 | Pond #375 in Queen Elizabeth Park, 33rd and Cambie in Vancouver. This is the pond at the base of the hill on E33rd Ave., below the golf course. As one enters the park on E33rd Ave., this pond is on the left side nearest the road (49°10'). *Myriophyllum heterophyllum* Michx. and *Myriophyllum spicatum* L. |
| 9 | The pond in the Japanese Gardens portion of the Park and Tilford Distilleries botanical gardens in North Vancouver, about 2 km west of the second narrows bridge (49°20'). *Myriophyllum brasiliense* Camb. |
| 10 | Lower Hatzic Slough just downstreawm from the bridge to Hatzic Island; the site is on the mud banks around the first island in the slough (49°10'). *Myriophyllum ussuriense* (Regal) Maxim. (There is some *M. spicatum* L. here too but growth is poor and very late starting due to very turbid water). |

TABLE 2

SAMPLING AND OBSERVATION DATES & SURFACE WATER TEMPERATURES (°C) FOR Myriophyllum SITES, FEBRUARY 1980 - JUNE 1981

| Dates - 1980 | | SITES 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Feb. | 2 | | | | | | X | X | X | X | X |
| | 22 | | X | X | | | | | | | |
| | 25 | | | | X | X | | | | | |
| Mar. | 3 | 4.5 | | | | | | | | | |
| | 12 | | 6.0 | 6.0 | 5.0 | 7.0 | | | | | |
| | 14 | 4.0 | | | | | | | | | |
| | 19 | | | | | | 9.0 | 7.0 | 9.0 | 8.0 | 8.0 |
| | 26 | | 7.0 | 8.0 | 5.5 | 8.0 | | | | | |
| | 27 | 7.0 | | | | | | | | | |
| Apr. | 9 | | 6.2 | 9.2 | 8.0 | 10.0 | | | | | |
| | 10 | | | | | | 11.0 | 10.5 | 10.0 | 10.0 | 13.0 |
| | 15 | 8.5 | | | | | | | | | |
| | 22 | | 9.0 | 11.0 | 12.0 | 13.5 | | | | | |
| | 24 | | | | | | 15.0 | 15.0 | 16.0 | 15.5 | 15.5 |
| | 30 | 10.5 | | | | | | | | | |
| May | 8 | | 12.5 | 13.0 | 15.5 | 17.0 | | | | | |
| | 12 | 15.5 | | | | | | | | | |
| | 21 | | | | | | 20.0 | | 22.0 | | 15.5 |
| | 23 | 16.0 | | | | | | | | | |
| | 26 | | 14.0 | 14.0 | 17.5 | 16.0 | | | | | |
| June | 3 | | | | | | 14.5 | 15.0 | 14.5 | 15.5 | 16.0 |
| | 16 | 20.0 | 16.5 | 18.5 | | | | | | | |
| | 18 | | | | 20.0 | 19.0 | | | | | |
| | 20 | | | | | | 18.0 | 22.0 | 21.0 | 22.0 | 20.5 |
| | 30 | | 18.5 | 19.5 | | 18.5 | | | | | |
| Jul. | 7 | | | | 21.5 | 19.2 | | | | | |
| | 11 | | | | | 20.0 | | | | | |
| | 14 | | | 21.0 | | | | | | | |
| | 15 | | 20.0 | | | | | | | | |
| | 16 | 21.0 | | | | | | | | | |
| | 17 | | | | | | 23.0 | 23.0 | 23.0 | 20.5 | 23.0 |
| | 25 | | | | | 23.5 | | | | | |
| Aug. | 5 | | | | 22.0 | | | | | | |
| | 13 | | | | 23.0 | 24.0 | | | | | |
| | 20 | 23.0 | 21.0 | 21.0 | | | | | | | |
| | 21 | | | | | | 18.0 | 21.0 | | 21.0 | 24.0 |
| | 22 | | | | | | | | 22.0 | | |

TABLE 2 (Continued)

| | | SITES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dates - 1980 | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Sep. | 2 | | | | | | 14.5 | | 16.0 | 16.0 | |
| | 3 | | | | | | | | | | 19.0 |
| | 4 | | | | | | | 20.0 | | | |
| | 19 | | | | | | 15.0 | | 14.0 | | 17.0 |
| | 22 | | | | | | | 15.0 | | 15.0 | |
| Oct. | 7 | 18.5 | 18.0 | 15.5 | | | | | | | |
| | 8 | | | | 16.0 | 16.0 | | | | | |
| | 20 | | | | | | 12.0 | 13.0 | 12.5 | 12.0 | 15.0 |
| | 29 | 13.0 | | | 11.0 | 11.0 | | | | | |
| | 30 | | 14.0 | 9.5 | | | | | | | |
| Nov. | 10 | | | | | | 9.5 | 10.0 | 9.0 | 10.0 | 12.0 |
| | 17 | 7.0 | 11.0 | 10.0 | | | | | | | |
| | 18 | | | | 8.0 | 8.0 | | | | | |
| | 25 | | | | | | 7.0 | 5.0 | 6.0 | 6.5 | 7.0 |
| Dec. | 8 | 3.0 | 8.0 | 6.5 | | | | | | | |
| | 11 | | | | 2.5 | 4.5 | | | | | |
| | 22 | | | | | | 7.0 | 7.0 | 7.5 | 9.0 | 5.5 |
| Dates - 1981 | | | | | | | | | | | |
| Jan. | 6 | | | | 5.0 | 6.5 | | | | | |
| | 7 | | | | | | 6.5 | 5.0 | 5.0 | 6.0 | 6.0 |
| | 21 | 7.0 | 7.5 | 8.0 | | | | | | | |
| | 23 | | | | | | 9.0 | 9.0 | 9.0 | 9.0 | |
| | 28 | | | | 5.0 | 6.0 | | | | | |
| Feb. | 17 | | | | | | 8.0 | 7.5 | 8.0 | 8.0 | 6.5 |
| | 24 | | | | 5.5 | 7.0 | | | | | |
| | 25 | | 7.0 | 7.5 | | | | | | | |
| Mar. | 18 | | | | | | 11.0 | 9.5 | 10.0 | 9.5 | 17.0 |
| | 24 | | | | 8.5 | 10.5 | | | | | |
| | 26 | 11.5 | 9.8 | 11.0 | | | | | | | |
| Apr. | 5 | | | | | | | | 14.0 | 10.0 | |
| | 8 | | | | | | 10.0 | 9.0 | | | 8.0 |
| | 27 | | | | 11.2 | 13.5 | | | | | |
| | 28 | 9.2 | 10.0 | 11.2 | | | | | | | |
| | 29 | | | | | | 12.3 | 13.4 | 13.5 | 12.5 | 13.2 |
| May | 15 | 12.0 | 11.5 | 12.5 | | | | | | | |
| | 20 | | | | 16.5 | 16.0 | | | | | |
| | 21 | | | | | | 14.0 | 15.0 | 14.0 | 14.5 | 16.0 |

TABLE 2 (Continued)

| Dates - 1980 | | SITES 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| June | 11 | | | | | | 16.5 | 17.0 | 16.5 | 15.0 | |
| | 17 | 15.0 | 15.5 | 15.5 | | | | | | | |
| | 18 | | | | 15.5 | 17.0 | | | | | |
| July | 2 | | | | | | 18.5 | 21.5 | 18.0 | 17.0 | 22.0 |

# CHAPTER 1
## M. brasiliense

The observation site for this species was the Japanese Gardens pool in the Park and Tilford Distillery Gardens of North Vancouver. The pool is up to 1 m deep and the Myriophyllum is planted in tubs in the deepest part of the pool. The tubs stay outside all year and gardeners indicate that the plants have been growing there for at least 4 years which has included a number of below freezing winters. The pond has been planted with several European and native B.C. aquatic and marsh plants and stocked with goldfish but is left in a fairly wild state except for a weeding and thinning program in the early spring. The surface shoots of M. brasiliense invade the marshy shallow areas, creep up the water fall and extend onto wet ground at pool-side; they are browsed by the goldfish.

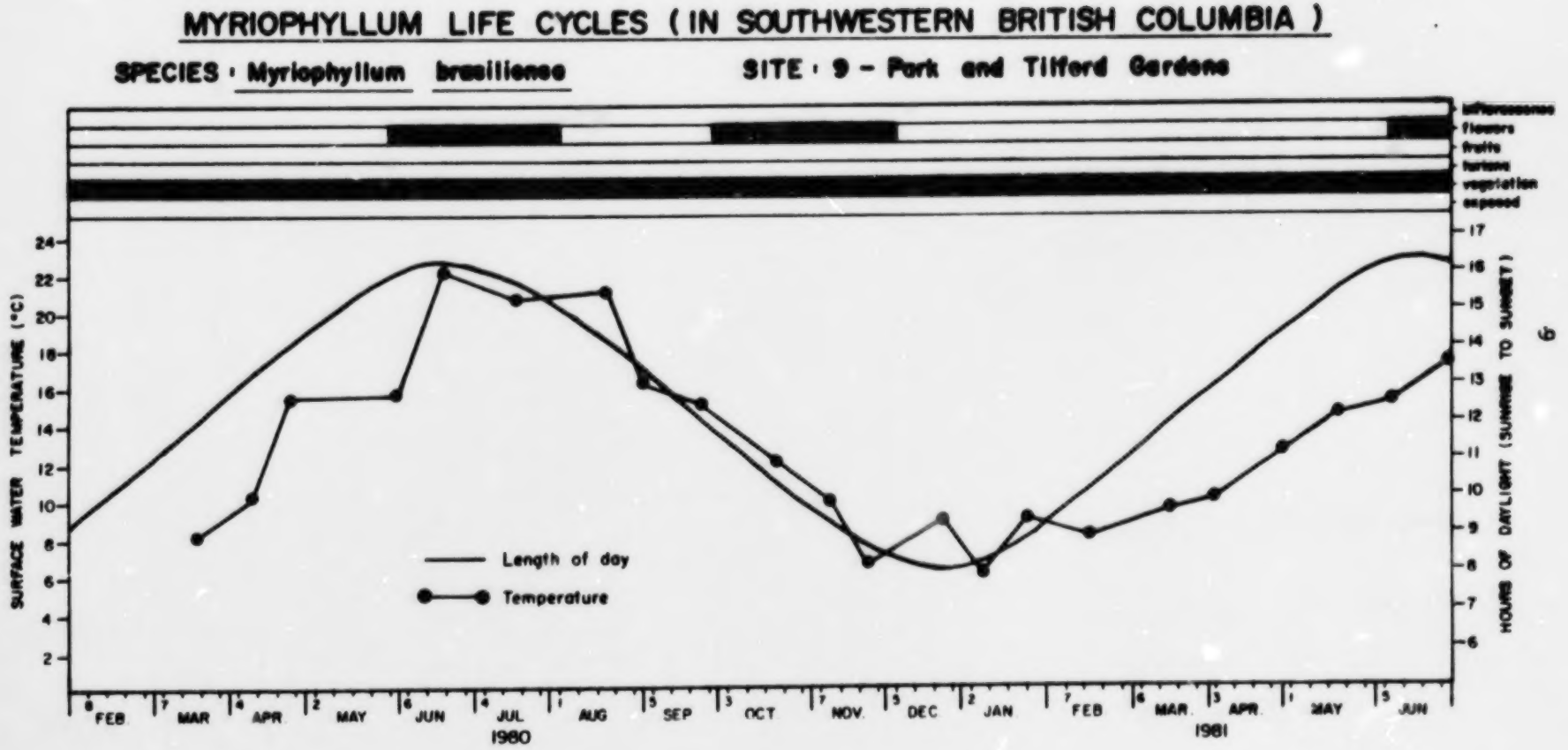
M. brasiliense has no distinct inflorescence but bears flowers in the axils of the surface stems; only pistillate plants are known thus no fruits are produced. No overwintering structures such as turions, are known, and the plant continues to grow all year. This is to be expected since the species is native to subtropical and tropical regions where overwintering strategies are not required. The plants may be cut back to the soil level or to short basal stem segments and will overwinter or go through a dormant period in this way and then regrow form lateral axillary buds or new shoots from the underground portions.

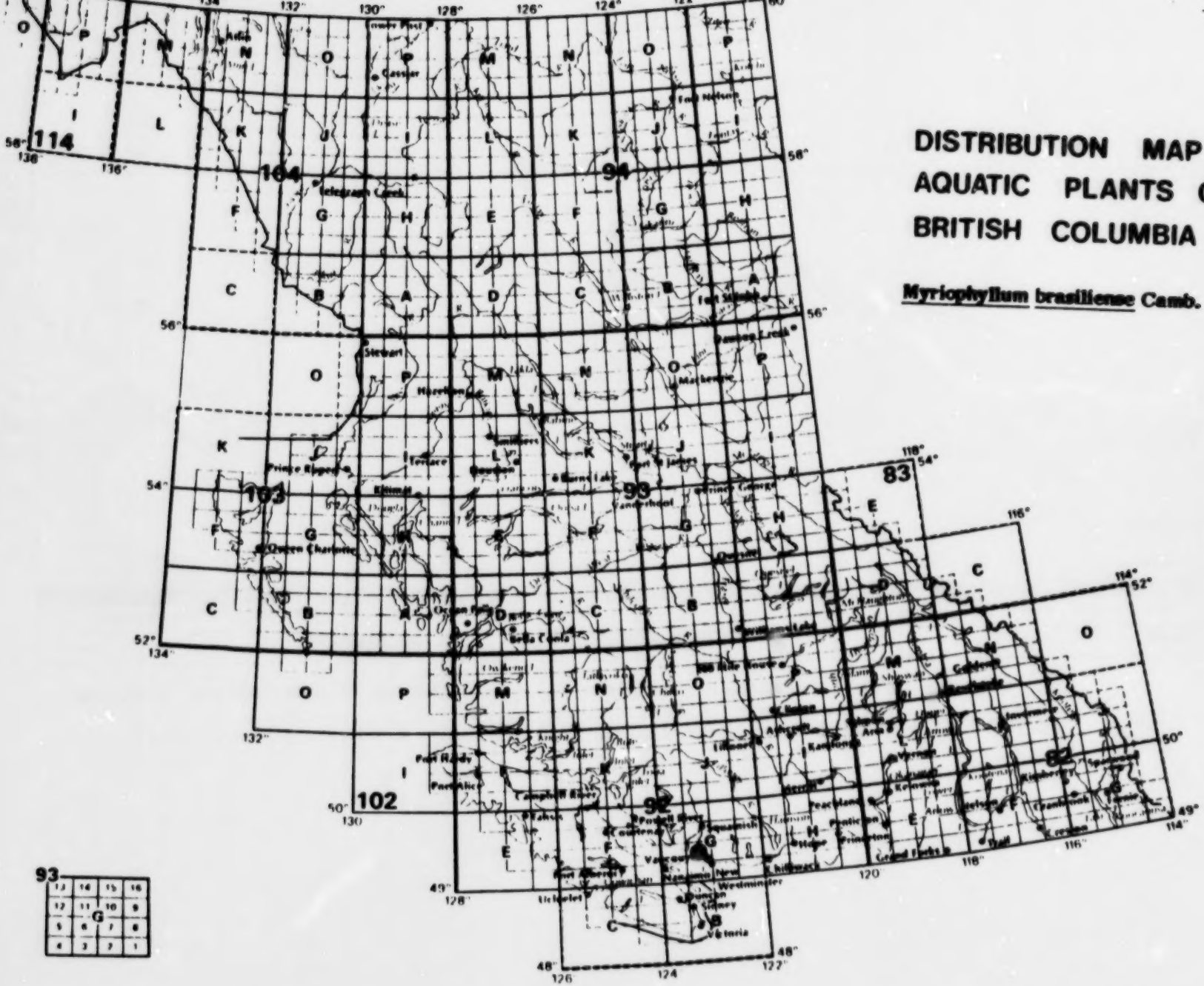
### OBSERVATIONS - FEBRUARY 1980 TO JUNE 1981

In February 1980 there were green, active vegetative stems both of the submerged finely dissected form and of the emergent creeping form even though the air temperature was around 0°C. By mid-March the amount of submerged vegetation had increased but the gardeners had weeded out the floating stems. In early April most of the submerged branches died and rotted and only a few new green shoots were visible, but by the end of April

considerable new submerged growth had taken place and there were many surfacing, creeping branches. Through June, July and early August, the plants spread vigorously over the water surface and remained in flower. From mid-August to mid-October the submerged leaves were gradually dying and rotting and being replaced by short green buds and small shoots. The surface branches were no longer growing so vigorously and were being attacked by black aphids. New aerial branches were numerous but short and compact compared to summer conditions. Flowering ceased for most of August and September, then began again in October. By November there were virtually no submerged leaves left and any submerged portions of aerial branches were growing vigorously and flowering. Some new submerged shoots were beginning to surface. Cut, broken or horizontal stems formed many long, white, adventitous roots with red root caps or tips. Flowering ceased in December but active surface growth and slow spread continued through January 1981. Weeding took place in February and March; some senescence of overwintering stems and leaves was occurring but these were constantly replaced by new growth. In March and April the submerged stems began to grow actively and reddish apices were produced but surfacing shoots were still in a fairly compact bud form and had not begun to spread over the surface of the water. By the end of May the submerged stems were large and bushy with reddish apices and the surface stems were spreading and branching.

Figure 1


MYRIOPHYLLUM LIFE CYCLES ( IN SOUTHWESTERN BRITISH COLUMBIA )
SPECIES : Myriophyllum brasiliense
SITE : 9 - Park and Tilford Gardens
inflorescence
flowers
fruits
turions
vegetation
exposed
SURFACE WATER TEMPERATURE (°C)
HOURS OF DAYLIGHT (SUNRISE TO SUNSET)
Length of day
Temperature
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
1980
1981


DISTRIBUTION MAP
AQUATIC PLANTS OF
BRITISH COLUMBIA
Myriophyllum brasiliense Camb.
114
104
94
103
93
83
102
92
Stewart
Prince Rupert
Terrace
Queen Charlotte
Port Hardy
Victoria
Nanaimo
Westminster
Kitimat
Smithers
Prince George
Dawson Creek
Fort Nelson
Telegraph Creek
Fort Simpson
Mackenzie
Grand Prairie
Peace River
Fort St. John
Revelstoke
Kamloops
Vernon
Kelowna
Penticton
Princeton
Hope
Squamish
Prince Rupert
Port Alice
Campbell River
Courtenay
Duncan
Sidney
Victoria
Nanaimo
Westminster
Vancouver
Hudson Hope
Fort Nelson
Fort Simpson
Mackenzie
Dawson Creek
Grand Prairie
Peace River
Fort St. John
Revelstoke
Kamloops
Vernon
Kelowna
Penticton
Princeton
Hope
Squamish
Whitehorse
Watson Lake
Telegraph Creek
Terrace
Kitimat
Smithers
Prince George
Quesnel
Williams Lake
Ashcroft
Lillooet
Pemberton
Whistler
Revelstoke
Golden
Invermere
Cranbrook
Fernie
Elkford
Fort Steele
Creston
Grand Forks
Rossland
Trail
Castlegar
Nelson
Kaslo
New Denver
Slocan
Nakusp
Arrowhead
Salmon Arm
Sicamous
Enderby
Armstrong
Vernon
Kelowna
Penticton
Princeton
Hope
Chilliwack
Abbotsford
Mission
Langley
Vancouver
Whistler
Pemberton
Lillooet
Ashcroft
Clinton
Cache Creek
Kamloops
Merritt
Logan Lake
Barriere
Clearwater
Valemount
Jasper
Hinton
Edson
Grande Prairie
Dawson Creek
Fort St. John
Fort Nelson
Fort Simpson
Mackenzie
Norman Wells
Inuvik
Tuktoyaktuk
Aklavik
Old Crow
Dawson

# CHAPTER 2
## M. elatinoides

This species was monitored in the Cowichan River just above the railroad bridge upstream from the highway crossing in the Village of Lake Cowichan. This site is in the main channel and subject to current flow all year; it is just downstream from the fish ladder, boat lock and weir at the outlet of Cowichan Lake. The water is up to 3 metres deep over sandy or gravelly substrates. Plants surface and flower only in the shallows and quieter water, those in the deeper main channel are kept submerged by the current. The population is very large and well established but whether it antedates the control structures on the end of Cowichan Lake is not known. M. elatinoides is also found in deep, quiet water in the lake itself but does not surface or flower in these conditions although it may reach heights of 4 metres.

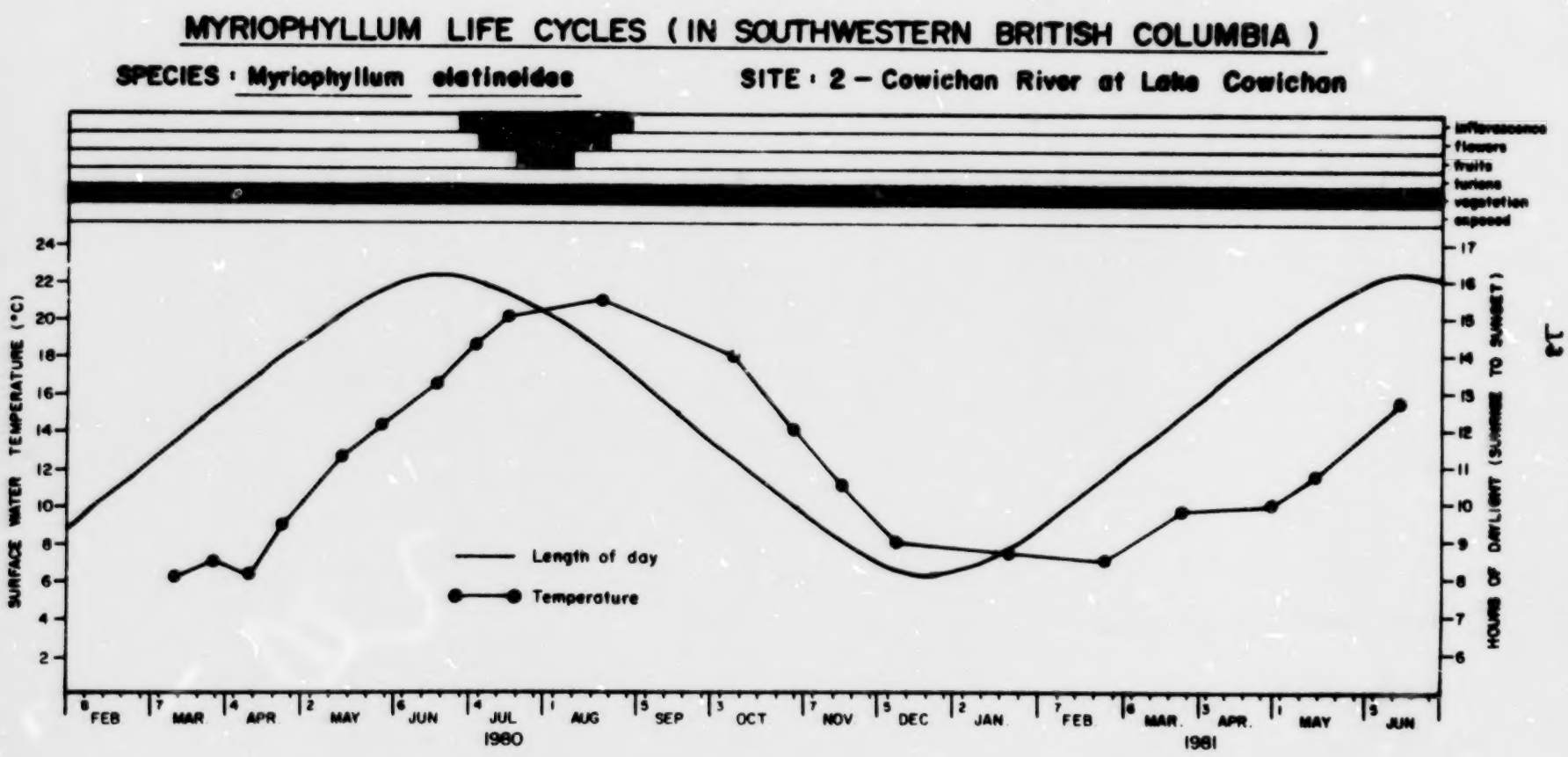
The plant is perennial from rhizomes and the root crown; no turions or specialized overwintering structures are formed. Flowering takes place on specialized terminal inflorescences which are emergent from the water. M. elatinoides is generally known as a subtropical southern hemisphere species but has a few known locations throughout the United States and Canada which are presumably introductions or escapes from cultivation or aquarium use. There are a number of sites in B.C., all on Vancouver Island, all in flowing water and mostly in relatively remote locations where the chances of human introduction appear very low.

### OBSERVATIONS - FEBRUARY 1980 TO JUNE 1981

Between February and June, the old overwintering vegetation gradually died and rotted; concurrently, new shoots arose from the roots or from basal axillary buds on the old stems. Adventitious roots formed on the old stems below the new green shoots. By June 1980 the new growth had elongated and surfaced in the shallows and, by the end of June, inflorescences were

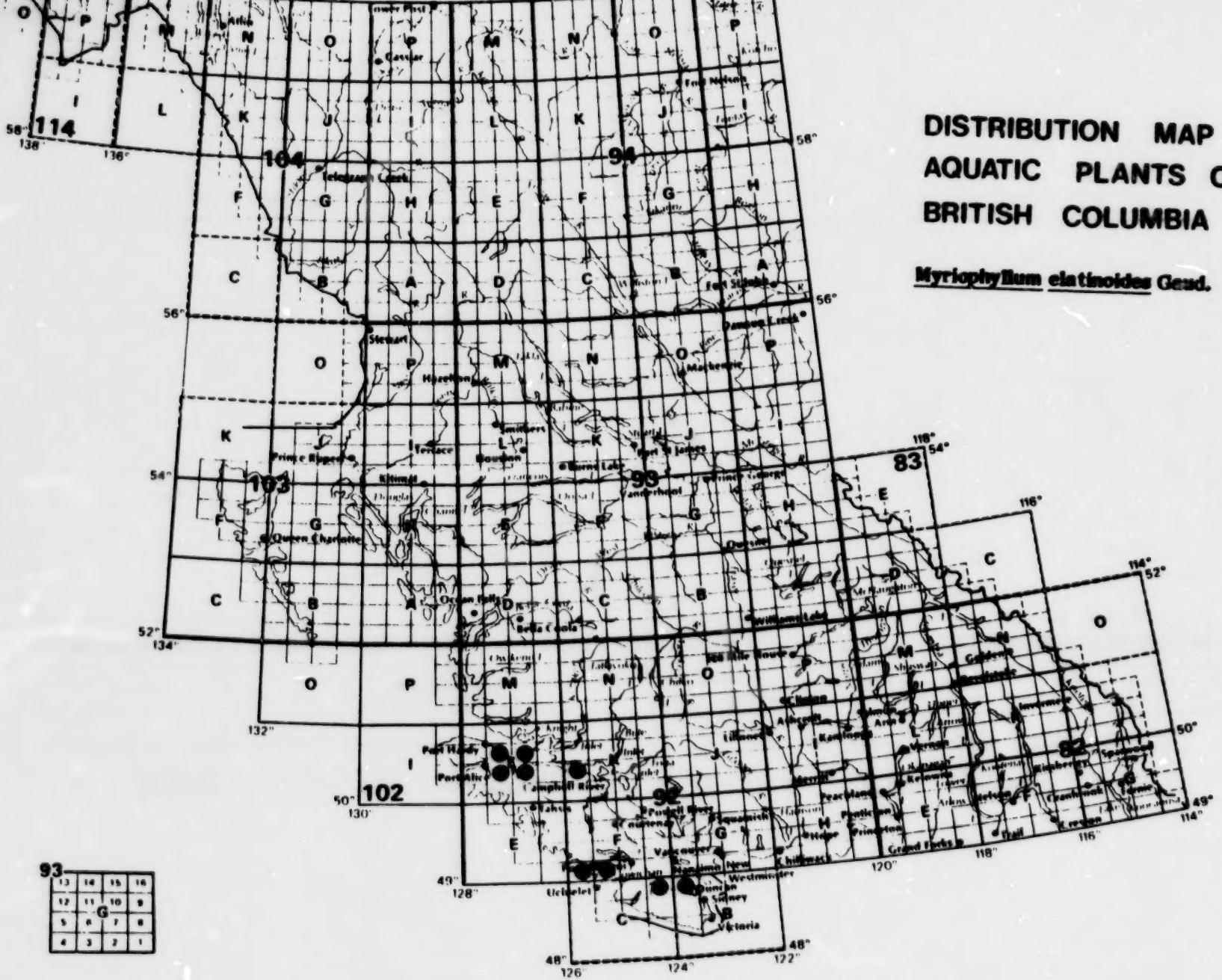
emerging in shallow water. In July the plants flowered; most flowers were female but a few males matured before rising water levels flooded the inflorescences. A few immature fruits formed before flooding. In August the plants were still flooded and very few flowers or fruits were left. The old stems continued to die gradually and be replaced by new growth. This continued into October with more new growth in deeper water and more die-off in the shallows. By the end of October most stems were bare and leafless at the base and covered in algae and periphyton; there were new green shoots at the base of the plant and the apices of the stems. From November to January 1981, more new basal stems grew and lay almost horizontal in the current, while almost all the old stems died and rotted. In February the plants were green and actively growing with new lateral and terminal buds. Through March and early April, most of the vegetation died and rotted with only a few new green basal or lateral shoots present. In April and May, this new growth elongated and multiplied; die-off of older stems slowed down so that by June there was a large, robust bed of M. elatinoides on the site again.

Figure 2


MYRIOPHYLLUM LIFE CYCLES ( IN SOUTHWESTERN BRITISH COLUMBIA )
SPECIES : Myriophyllum elatinoides
SITE : 2 – Cowichan River at Lake Cowichan
inflorescence
flowers
fruits
turions
vegetation
exposed
SURFACE WATER TEMPERATURE (°C)
HOURS OF DAYLIGHT (SUNRISE TO SUNSET)
Length of day
Temperature
FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN
1980
1981

# DISTRIBUTION MAP AQUATIC PLANTS OF BRITISH COLUMBIA

**Myriophyllum elatinoides** Gaud.



# CHAPTER 3
## M. exalbescens

Diver Lake in Nanaimo was the site where observations on M. exalbescens were made. The site is at the public beach area at the end of Black Frank Road. This was once an acidic bog area and has some old coal waste tips along parts of the shore. Sand was dumped to make a shallow firm beach and these disturbances have apparently stimulated plant growth to the extent that "No Swimming" signs have been posted.

There is a heavy industry area at the east end of the lake and considerable residential development along the west side. The lake is small and relatively shallow with high density M. exalbescens beds surfacing everywhere except in the deeper central portion. Numerous complaints have been registered about this aquatic weed problem and considerable newspaper publicity has been generated.

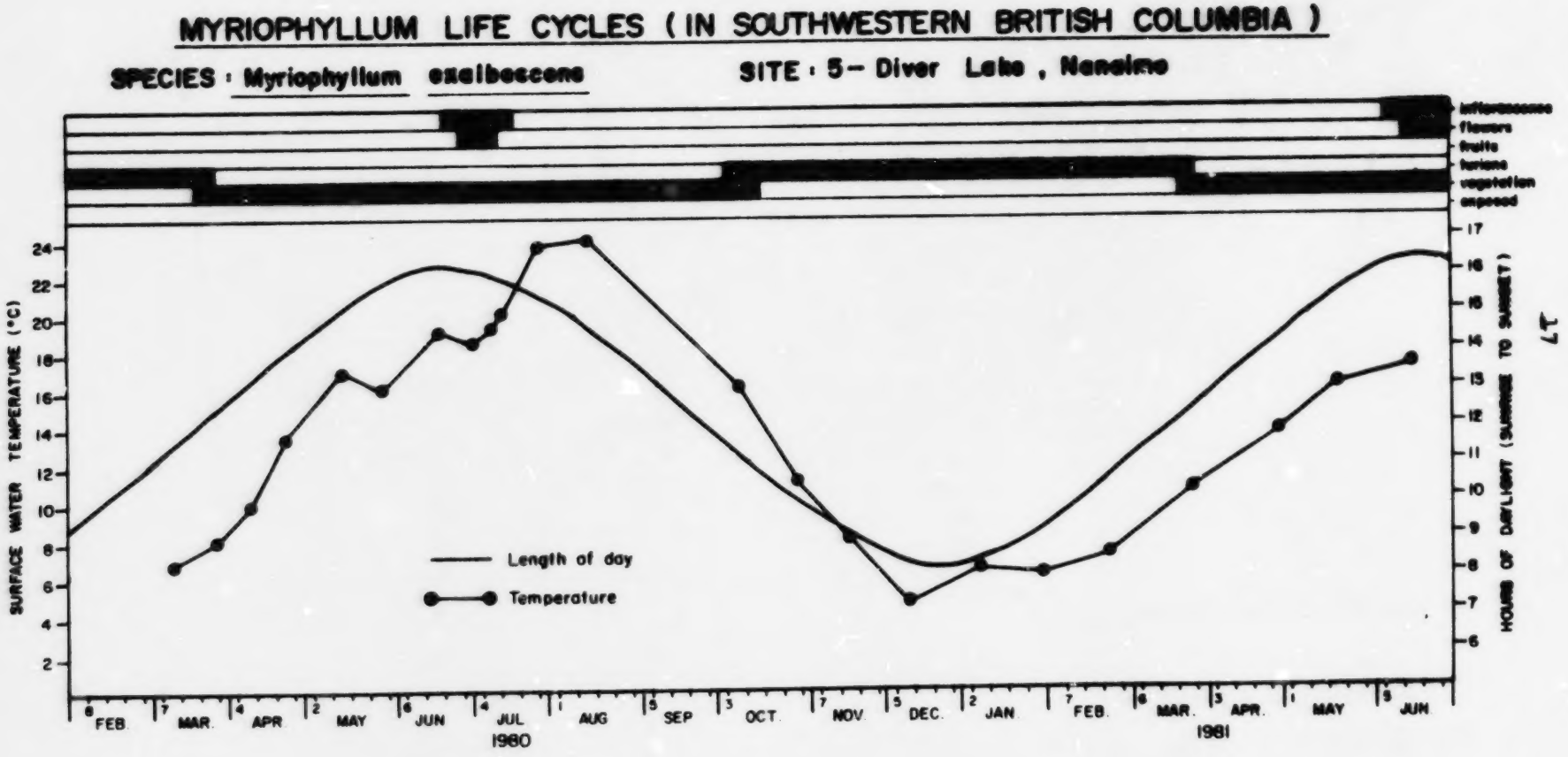
M. exalbescens is a native B.C. aquatic plant and is both widespread and common throughout the province. The plant forms turions in the fall and overwinters in this fashion. The vegetative parts all eventually die and rot and all new growth in the spring arises from germinating turions. This species forms distinct emergent inflorescences, from the apices of the stems, which bear female flowers below and male flowers above. Fruit formation is common in most areas unless the water level rises during flowering season and submerges the flowers.

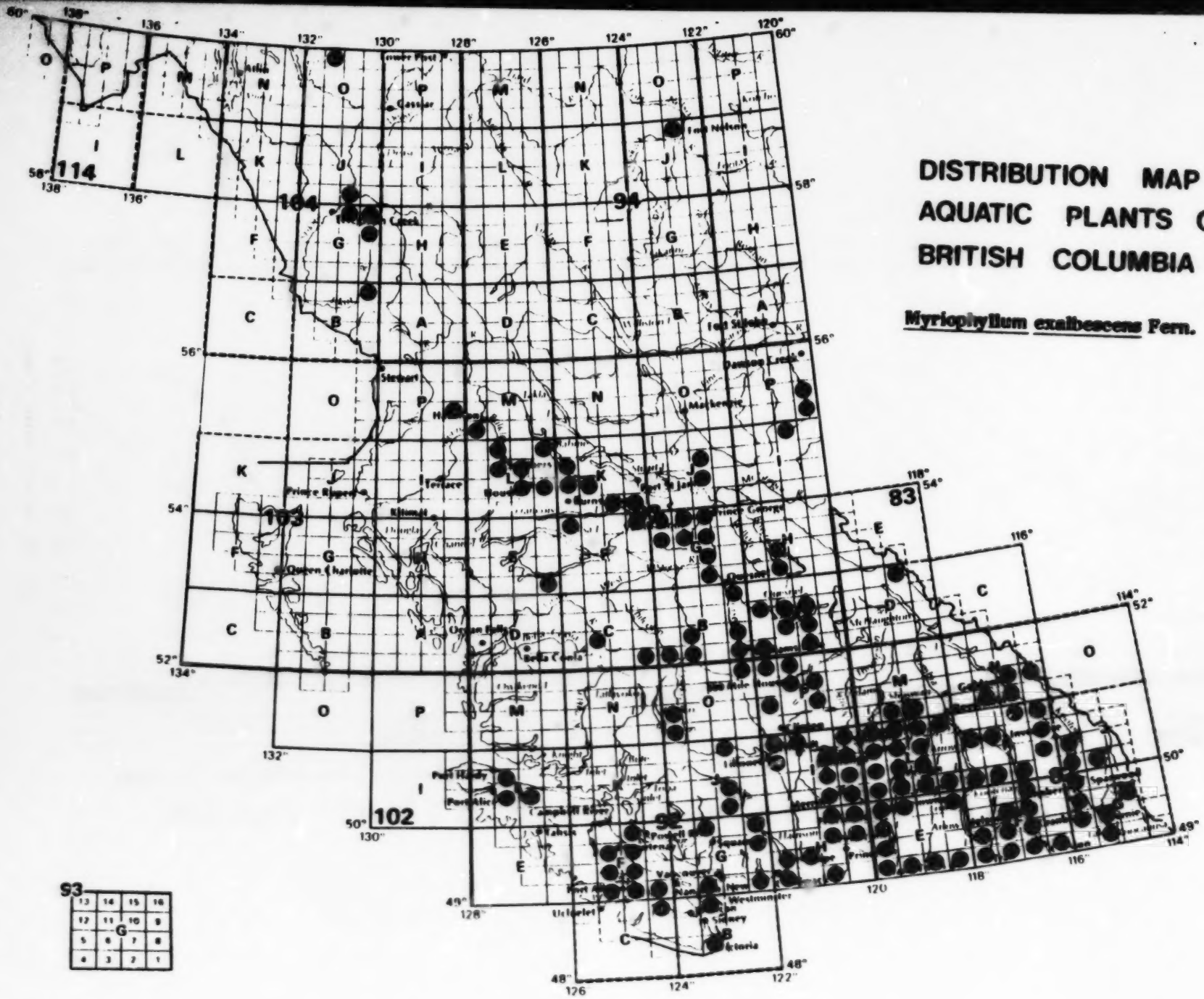
### OBSERVATIONS - FEBRUARY 1980 TO JUNE 1981

In February 1980 there was very little of the previous years vegetation left, mostly bare stems. Many turions were seen lying dormant on the bottom of the lake. By the end of March all the old plants had rotted and the turions were just beginning to elongate and form adventitious roots at the base. The plants were all erect and rooted in the sediments, up to 0.3 m

tall, red-tipped and beginning to branch by the end of April. In May the plants grew vigorously, reaching the surface in shallow water and branching; this continued through June as deeper plants surfaced. Deep plants had whiter stems, longer internodes and did not branch until nearly at the surface. Flowering began at the end of June on emergent inflorescences and continued into July. The water level rose and flooded the plants this year and no fruit was formed. Plants continued to reach the surface and branch through the end of September and plant density increased. Where stems ran horizontally, adventitious roots were often formed. In October, as water levels and temperatures dropped, the plants began to die and became covered in periphyton. Both apical and lateral turions formed in abundance at this time and most remained on the plant until the stems rotted and fell to the bottom. Through November, December and January more plants died and rotted and more turions became free of the old vegetation. In the occasional warm periods during the winter months, turions put on a little growth. By the end of February 1981 adventitious roots were beginning to appear on some turions. Axis elongation occurred in March, but new vegetative growth did not occur until April. In late May, emergent inflorescences reappeared, followed by flowers in early June.

Figure 3


MYRIOPHYLLUM LIFE CYCLES ( IN SOUTHWESTERN BRITISH COLUMBIA )
SPECIES : Myriophyllum exalbescens
SITE : 5 – Diver Lake , Nanaimo
inflorescence
flowers
fruits
turions
vegetation
exposed
SURFACE WATER TEMPERATURE (°C)
HOURS OF DAYLIGHT (SUNRISE TO SUNSET)
Length of day
Temperature
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
1980
1981




# DISTRIBUTION MAP AQUATIC PLANTS OF BRITISH COLUMBIA

**Myriophyllum exalbescens Fern.**

# CHAPTER 4
## M. farwellii

This species was monitored in Echo Lake, which is on the highway between Campbell River and Buttle Lake. The site is under an old logging road bridge at the west end of the lake beside a logging camp (formerly Elk River Timber but now M & B). Access is through the camp on an active logging road or across the lake from several camping and picnic sites. The lake is quite small and shallow but rich in aquatic plant density along the margins. The depth of the site varies from 0 to 3 metres and the bottom is quite organic and littered with wood debris. This site freezes solid in the winter but the plants continue to grow under the ice.

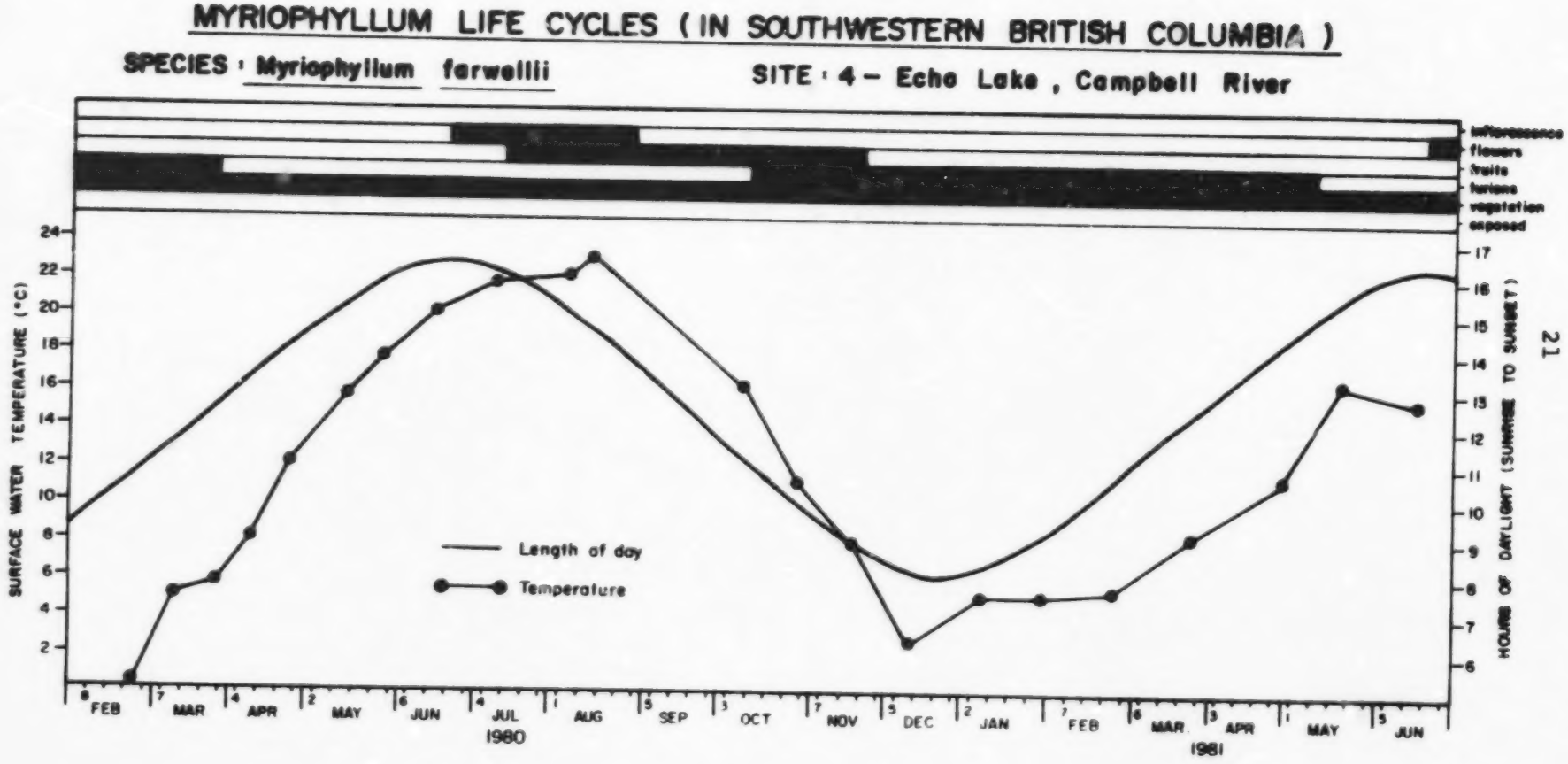
M. farwellii has no distinct inflorescence but bears flowers and fruits in the axils of regular submerged leaves near the top of the stems. The stems continue to grow after the flowering season so the fruits end up midway on the stem later in the season. This species has quite reddish leaves and stems and often grows in highly organic sites where the water is quite reddish-brown and visibility is poor; since there is no emergent inflorescence the plant is hard to find and often overlooked. Fruits are produced in large numbers and apical turions are also abundant. These turions are quite small, reddish and cylindrical. Since the plant overwinters in an active vegetative state both turions and fruits are present on the plants most of the fall and winter. M. farwellii has been found on northern Vancouver Island, the south-western corner of the mainland, at one site near Yahk, SE of Kootenay Lake, and at one site near Clearwater Lake.

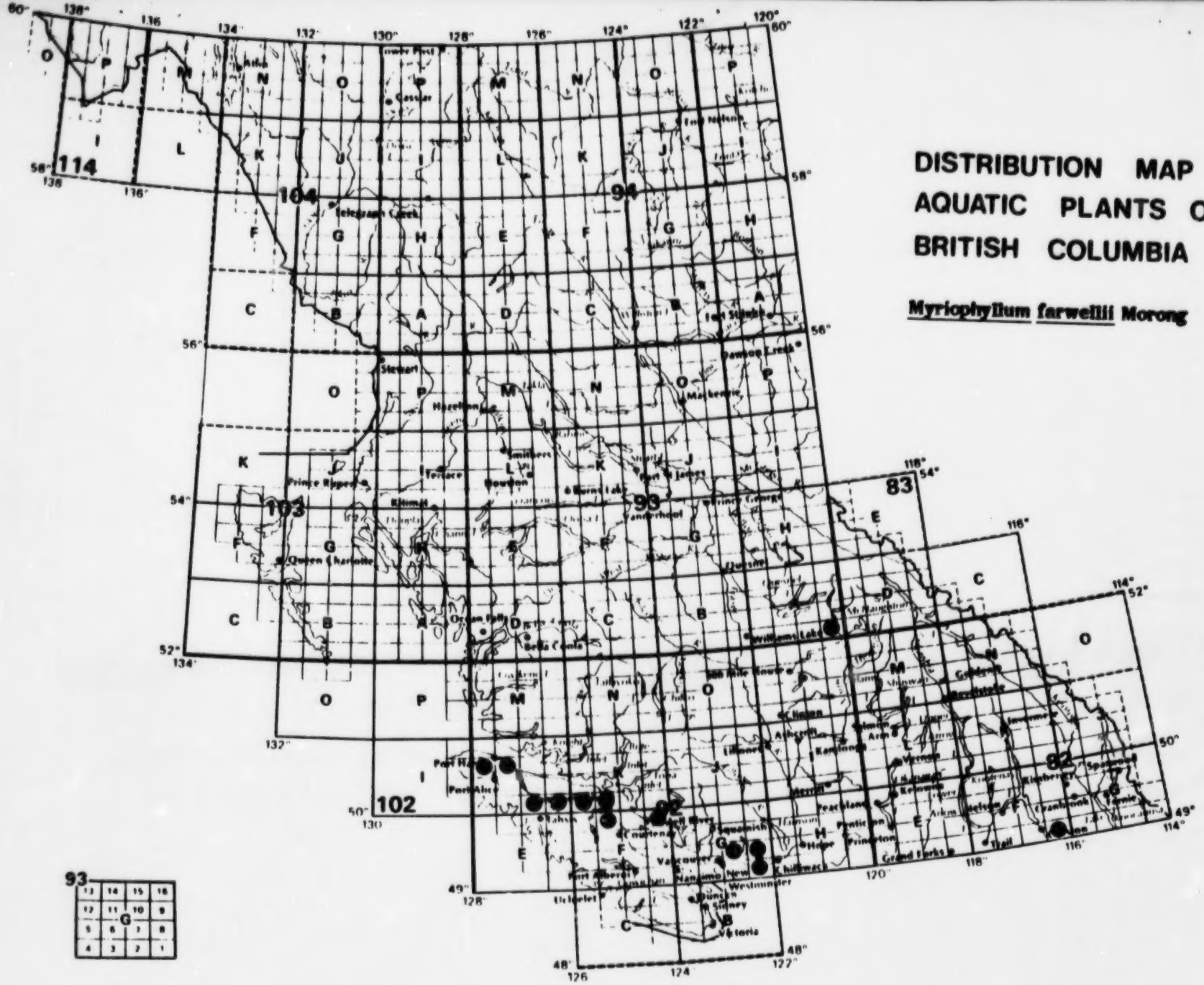
### OBSERVATIONS - FEBRUARY 1980 TO JUNE 1981

In February 1980 the surface of the lake was frozen deep enough to walk on. The ice was clear with no snow cover and plants could be seen through the ice. They had reddish apical turions attached and a few new green branches. They were still growing in a narrow zone of meltwater around each

plant, though the water column was frozen. There was a thin layer of melt-water on the surface of the ice and there were green fragments of M. farwellii floating in this water. By the end of March there were many new green shoots from lateral buds, from the roots, and from expanding turions; the old wintering stems were beginning to show signs of senescence. There were still some unexpanded turions present. There was little change through April, but by May almost all turions had elongated several centimetres, and adventitious roots were forming at the base of the turions. The old, over-wintering stems were mostly brown, covered in periphyton and senescent. By the end of May and into June most old stems were dead but some were still present, reclining on the bottom and sending up new axillary shoots and adventitious roots. New vegetative growth was very red and bushy, well branched, and in dense beds. A few flowers appeared by the end of June. Through July and August the plants were in full flower and fruits began to appear in mid July. The vegetation continued to grow vigorously and was still red. By October flowering was finished but fruits were very evident; apical turions were forming and a few new green shoots were evident. The plants were surfacing in dense reddish mats in the shallows and still actively growing; epiphytic periphyton was sparse. The tips of horizontal stems turned up and had dark, dense leaves and red turions on the tip. In November and December the old reddish stems were becoming senescent but new green shoots were present; few fruits were left on the plants, most had split into four segments and fallen off. The stem apices were dark green, compact and had apical red turions. By the end of February almost all the old senescent plants were gone and only the new green growth was left. All seeds were gone but turions were still present on the old stems. At the end of March most of the turions were beginning to expand, very few green shoots were present and most of the overwintering vegetation was gone. In May some old horizontal stems were producing adventitious roots and shoots at the nodes and apical turions were elongating and branching. Turion leaves were small and reddish while new post-turion leaves were larger and green. In June there were many new green shoots up to a half-metre long. These were not yet surfacing. A few flowers were present in apical leaf axes.

Figure 4


MYRIOPHYLLUM LIFE CYCLES ( IN SOUTHWESTERN BRITISH COLUMBIA )
SPECIES : Myriophyllum farwellii
SITE : 4 – Echo Lake , Campbell River
inflorescence
flowers
fruits
turions
vegetation
exposed
SURFACE WATER TEMPERATURE (°C)
HOURS OF DAYLIGHT (SUNRISE TO SUNSET)
Length of day
Temperature
FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN
1980
1981




# DISTRIBUTION MAP AQUATIC PLANTS OF BRITISH COLUMBIA

**Myriophyllum farwellii Morong**

# CHAPTER 5
## M. heterophyllum

The sampling site for M. heterophyllum was a pond (#375) in Queen Elizabeth Park, 33rd and Cambie, in Vancouver. This is the upper pond at the base of the hill below the Pitch and Putt Golf Course, just southwest of the junction of East 33rd and Ontario Streets, on the road up to the Conservatory. There are three nearby ponds with token populations of M. heterophyllum which have been stable for at least 3-4 years but at this site population expansion is underway with M. heterophyllum apparently outcompeting M. spicatum, which is also found in this pond. The water is no more than 1/2 metre deep and in June and July the entire surface is covered with surfacing, flowering plants of these two species of Myriophyllum. At the end of summer the pond becomes a mess of rotting vegetation, yet no complaints have been received about this site in spite of extensive milfoil public awareness activities.

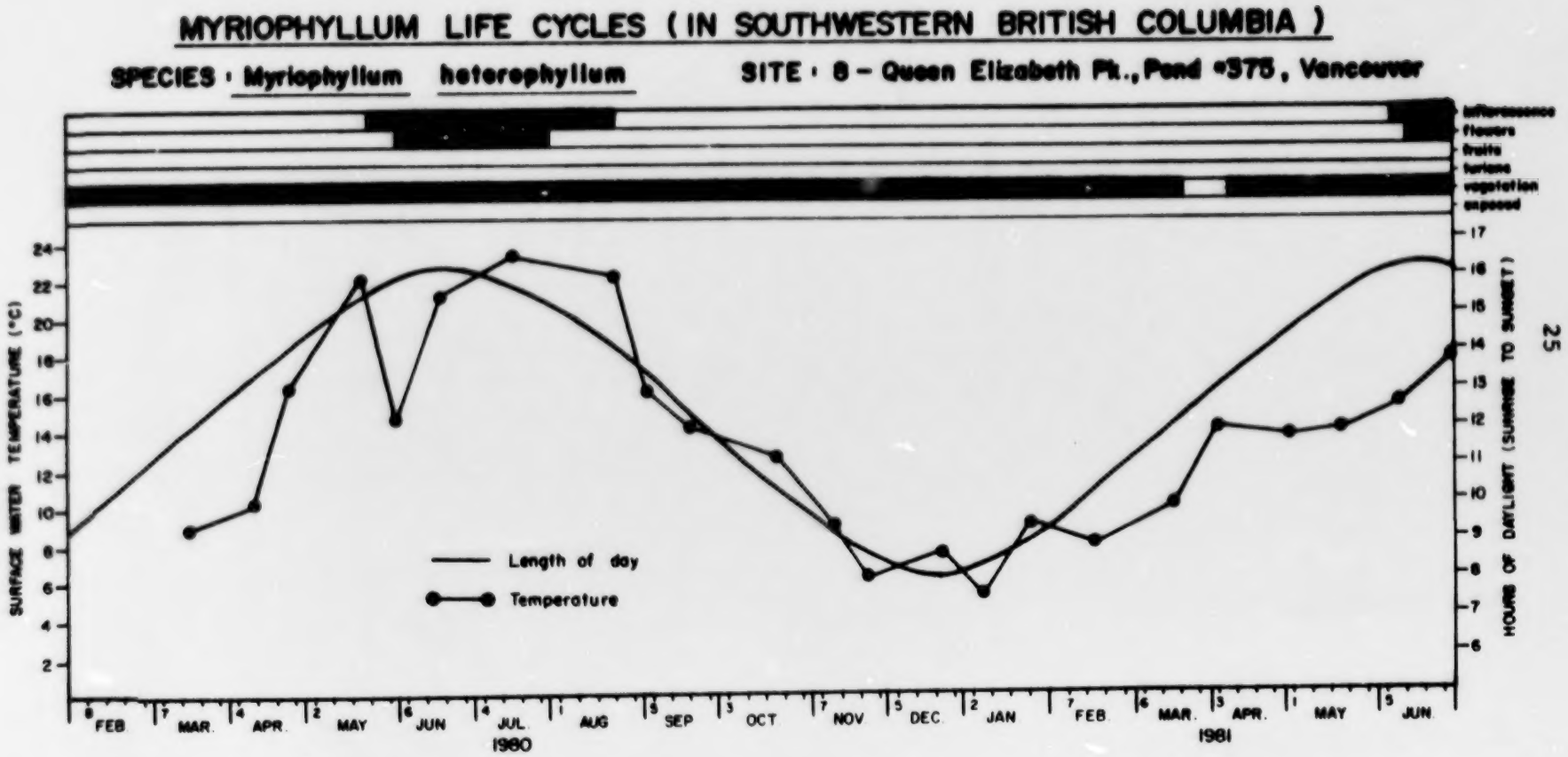
Both species were probably introduced but when, and from what source, is not known. The Myriophyllum in this pond is distinct from most of the rest of the Fraser Valley populations called M. hippuroides and is tentatively assigned to M. heterophyllum. Many observations and several distribution maps have been made over the last few years which lead to the conclusion that under these conditions M. heterophyllum does not spread to new sites as fast as M. spicatum but, once established, it outcompetes M. spicatum for growing space.

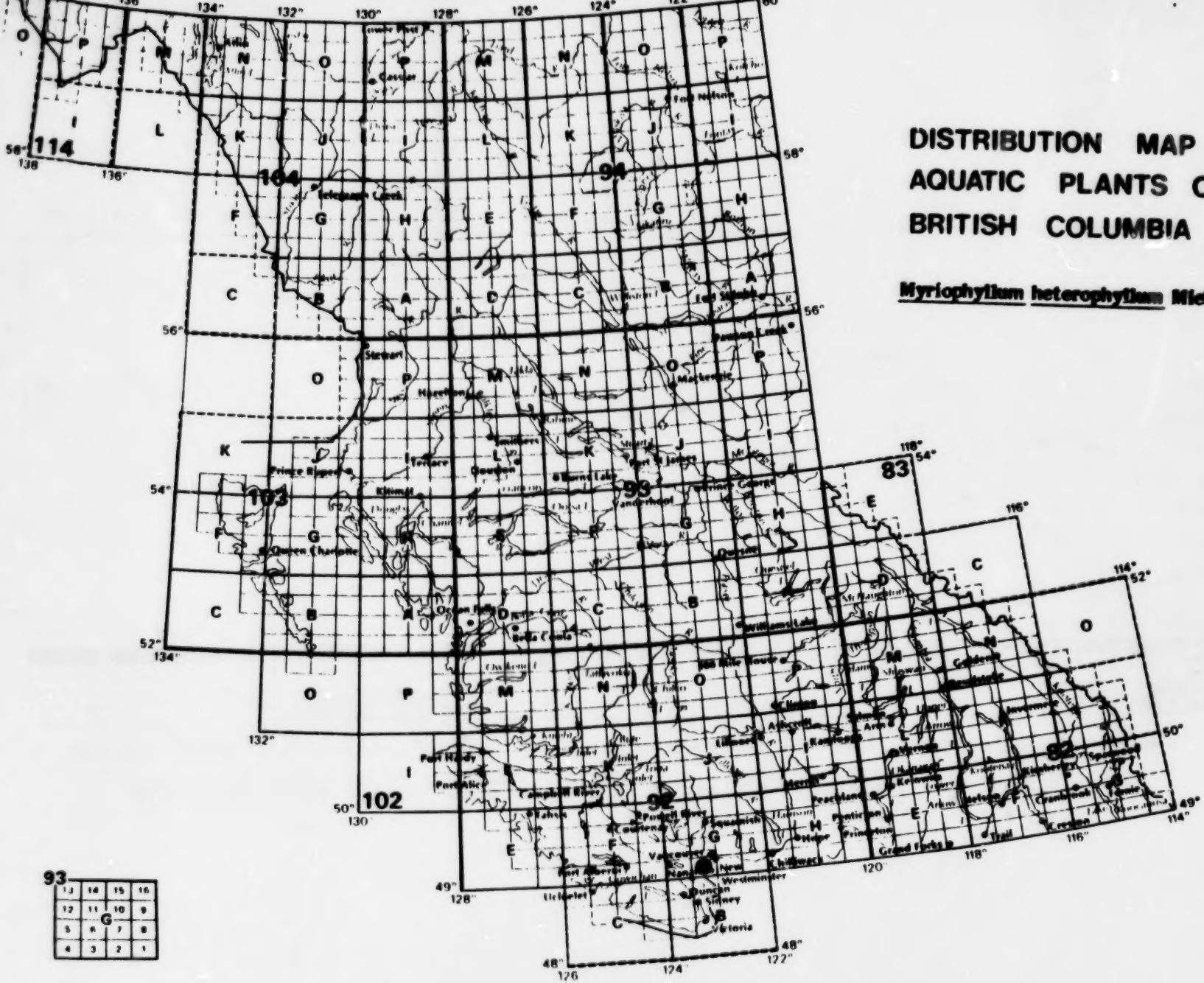
M. heterophyllum is rooted in the mud, much branched, and bears flowers on an emergent inflorescence which is green and swollen to a larger diameter than the rest of the stem. Female flowers are found at the base of the inflorescence and male flowers above. Fruiting is uncommon. The inflorescences stay on the plant over winter but most of the old stem is senescent and covered in periphyton. New, green, short shoots arise from the base of the plant in the fall and overwinter in a green, active state. This species does not have turions.

## OBSERVATIONS - FEBRUARY 1980 TO JUNE 1981

In February and March 1980 the old vegetation was still present but not active; new green shoots were prevalent and surfacing by the end of March. These arose from the roots and base of the plant. In April most of the old stems were dying and rotting and the new growth became dominant and surfaced. Some new growth came from apical and lateral portions of old stems which rooted at the nodes. By the end of May, emergent inflorescences were present and the vegetative growth was very vigorous. Female flowers appeared in early June and males by the end of June. Most flowers were gone by mid July but no fruits formed. In August the apical floating portions of the old stems were rotting but many new green stems were evident from the base of the plant. This continued into September and October when most old vegetation had died and only inflorescences were left. The young, green submerged shoots were still evident and active. Little change occurred from November through January when there were a few old stem apices and inflorescences left with new growth at the tip, but most growth was in the form of new green, basal, stems. In February and March the last of the old stems and inflorescences rotted and the overwintering green growth became covered in periphyton and senescent. In April new basal shoots arose and surfaced; they were quite bushy, luxuriant and reddish but became green later in the month. Growth continued in May and inflorescences emerged in early June with female flowers and male buds which opened late in June.

Figure 5


MYRIOPHYLLUM LIFE CYCLES (IN SOUTHWESTERN BRITISH COLUMBIA)
SPECIES · Myriophyllum heterophyllum
SITE · 8 – Queen Elizabeth Pk., Pond #375, Vancouver
inflorescence
flowers
fruits
turions
vegetation
exposed
SURFACE WATER TEMPERATURE (°C)
HOURS OF DAYLIGHT (SUNRISE TO SUNSET)
Length of day
Temperature
8 FEB
7 MAR
4 APR
2 MAY
6 JUN
4 JUL
1980
1 AUG
5 SEP
3 OCT
7 NOV
5 DEC
2 JAN
7 FEB
6 MAR
3 APR
1 MAY
5 JUN
1981


DISTRIBUTION MAP
AQUATIC PLANTS OF
BRITISH COLUMBIA
Myriophyllum heterophyllum Michx.
114
104
94
103
93
83
102
92
82
93

# CHAPTER 6
## M. hippuroides

The observation site for M. hippuroides was a drainage ditch in Pitt Meadows at a point where a large culvert passes under the road. This is about 1 km before the boat launch site where Pitt Lake flows into Grant Narrows. Nearly all the ditches in this area have very dense populations of M. hippuroides which appears to be the dominant plant in such habitats throughout much of the Fraser Valley north of the Fraser and west of the Harrison River. Drainage and irrigation ditches, and sloughs with pump stations on them, are all densely populated with M. hippuroides, yet no complaints have been received about this species.

In B.C. the plant is confined to shallow, silty, eutrophic sites with low flows and generally in narrow ditches, not open expanses of water. M. ussuriense is common in the shallow, periodically exposed, areas of Pitt Meadows and often grows in conjunction with M. hippuroides. M. hippuroides is quite similar to M. heterophyllum and is probably often confused with the latter, especially when not flowering. It is possible that they should be considered as the same species but they are presently maintained as distinct entities.

M. hippuroides is rooted in the mud, generally unbranched at least until surfacing and bears flowers on an emergent inflorescence. The inflorescence axis does not seem to be as swollen as in M. heterophyllum and the bracts seem more finely divided. Female flowers are found at the base of the inflorescence and male flowers above; fruiting is uncommon. The inflorescences stay on the plants throughout most of the winter, and while the old stems die, new young shoots take their place so as to keep the plant green almost all year. No turions are formed.

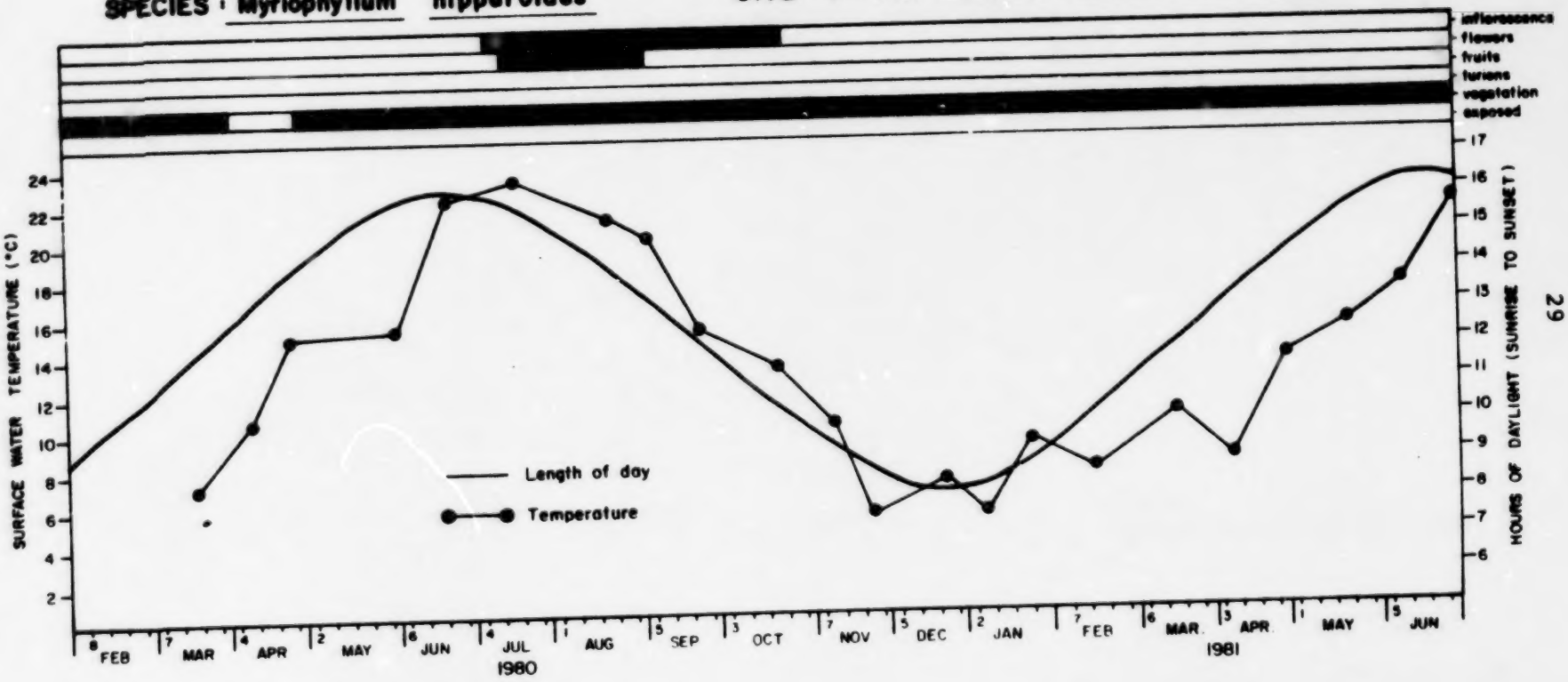
## OBSERVATIONS - FEBRUARY 1980 TO JUNE 1981

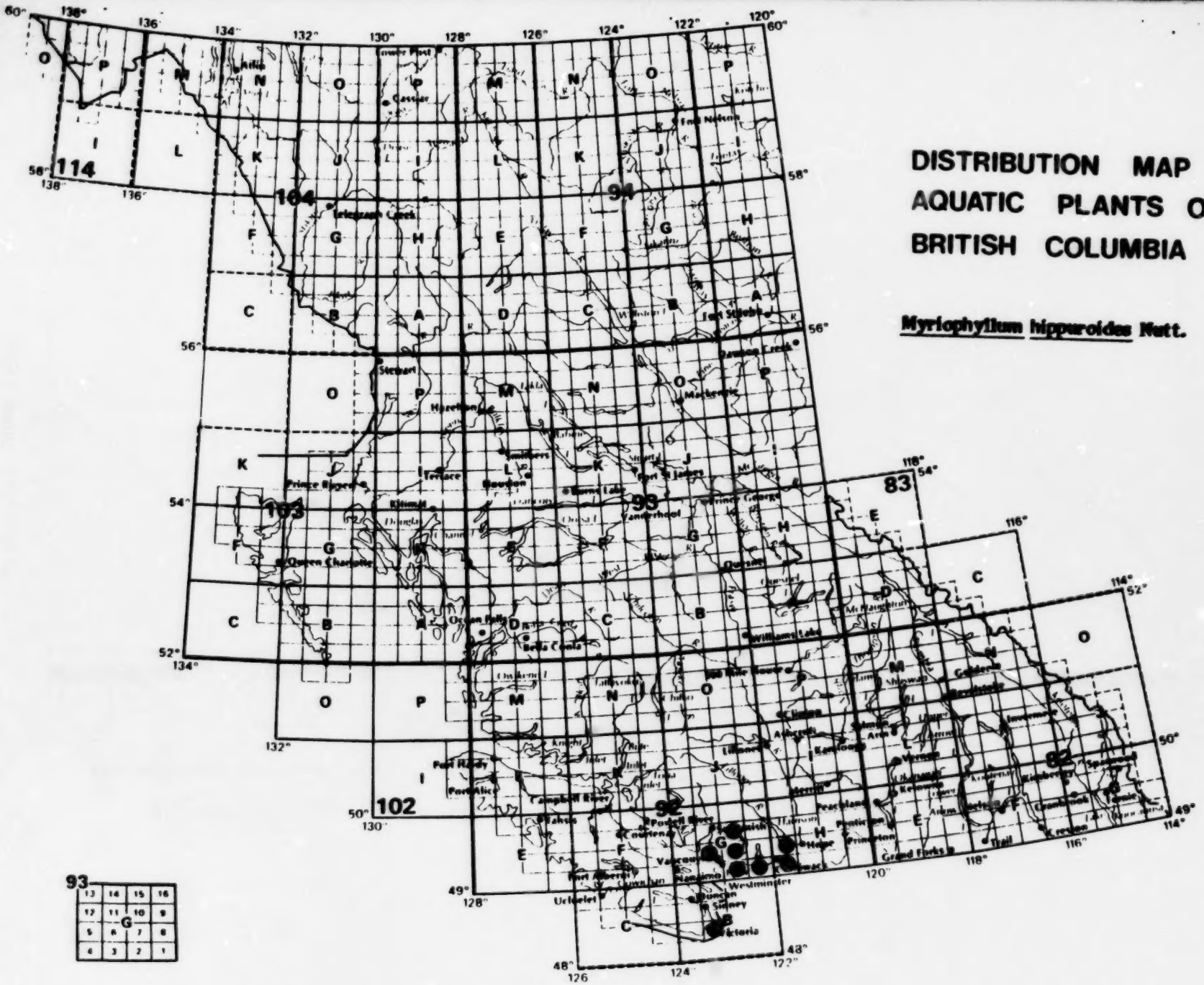
Through February and March the plants were active and growing with short, new, bright green branches on stem tips and arising from the roots. No turions were found. In early April virtually all vegetation died and disappeared and regrowth appeared only in late April. By June the plants were in full, vigorous, vegetative growth and surfacing with reddish tips. Flowering began on emergent inflorescence in mid-July with the plants remaining quite reddish. Flowering continued through August but water levels rose and submerged the flowers; thus no fruits were formed. Vegetation was still growing actively, green below and reddish at the tips. In September the inflorescences were still green and emergent but had no flowers or fruits; vegetation began to be senescent and covered in periphyton. Through October and November gradual senescence of old stems occurred and no new growth was evident. The old vegetation remained alive in December and by January some new green growth was evident. The old growth gradually died through the spring as new growth took its place. Old stems formed new growth at the tips and adventitious roots at the base by late January. In February and March there was a gradual increase in new green shoots as old stems died but no surfacing occurred. By the end of April almost all old growth was gone and new shoots were prevalent; these surfaced in places in May. In June the surfacing new growth showed red tips. The apices tended to be tapered as opposed to the rounded apices of M. heterophyllum. Throughout the winter and spring the new green growth on the M. hippuroides was consistently less robust and bushy than that of M. heterophyllum.

Figure 6

## MYRIOPHYLLUM LIFE CYCLES ( IN SOUTHWESTERN BRITISH COLUMBIA )

SPECIES : Myriophyllum hippuroides SITE : 7 – Pitt Meadows Ditches , Pitt Lake




DISTRIBUTION MAP
AQUATIC PLANTS OF
BRITISH COLUMBIA
Myriophyllum hippuroides Nutt.
114
104
94
103
93
83
102
92
82
93
G

# CHAPTER 7
# M. spicatum

M. spicatum was observed at two sites in the Vancouver area, Centennial Park Pond and Queen Elizabeth Park. These two sites are treated separately below.

In B.C. there are two morphological forms of M. spicatum; one larger and more robust, is typical of the Okanagan lakes but is also found in Hatzic Lake and Cultus Lake in the Fraser Valley; the second smaller form is generally in shallow, small ponds and ditches throughout the entire Fraser Valley. It is this latter form which was observed in the two sites.

M. spicatum grows in water up to 5 m deep and also grows as an emergent forming a moss-like carpet on exposed damp sand or mud as water levels fall. Plants grow in virtually all substrates from rocks through sand and silt or clays; they grow more luxuriantly in nutrient rich sites but will grow successfully in mesotrophic locations. Fluctuating water levels are not a detriment to growth but may prevent flowering and fruiting.

The plant grows rooted in the sediment as a perennial from a root crown and propagates primarily by tip layering and fragmentation. While seeds are produced and experimental work shows that they are viable and germinate, there is no evidence that seeds are an important part of the natural M. spicatum propagation and overwintering strategy. M. spicatum bears flowers on a specialized emergent inflorescence. Female flowers mature first in lower whorls and males later, above; almost exactly like those of M. exalbescens. Seeds are often produced in large numbers but may be aborted or prevented if water levels rise too soon after flowering. No turions are formed by M. spicatum. This plant can grow in very dense surfacing beds which are of considerable nuisance and prevent other uses of the water. In late summer most of the biomass is at the surface and the lower stems have very few leaves and long internodes.

## CENTENNIAL PARK POND, BEACH GROVE

This is a man-made pond on the edge of the beach on the west side of Boundary Bay. The pond is small and shallow, up to 1 m deep and sandy on the bottom and around the edges. Nymphaea has been planted here but otherwise M. spicatum covers the entire pond in a very dense bed. Municipal authorities dredge the pond from time to time but this has had no appreciable effect on M. spicatum which has been reported as a nuisance. Waterfowl frequent the pond, the nearby drainage ditches and water hazards on the Beach Grove Golf Course; all of which have M. spicatum populations. A feeder ditch for a pumping station which discharges to Boundary Bay also has some M. spicatum. In late summer when the water level drops, the wet margins of the pond are covered in moss-like carpets of semi-terrestrial emergent M. spicatum. The pond was last dredged in the fall of 1979 and the roadside ditch was cleared in September, 1980. Spoil from this latter dredging was dumped on a nearby farmer's field.

## OBSERVATIONS - FEBRUARY 1980 TO JUNE 1981

Since the pond had been dredged in the fall of 1979, the plant density was low in Feburary but those plants present were green and growing. By mid-March there was up to 15 cm of new growth on the stems. In early April there were only a few rooted plants and some fragments left; the rest of the plants were apparently harvested and piled along the shore. The plants left were very reddish with compact red buds and heavily covered in filamentous green algae; by the end of the month they were in full vegetative growth again with many branches and red tips. Towards the end of May, plants were surfacing and had completely re-occupied the entire pond. In early June vegetative growth was luxuriant and vigorous; both male and female flowers were present, and due to dropping water levels, there were many terrestrial plants of M. spicatum around the margin. In late June the plants were in full flower and a few young fruits were evident. Plants continued to flower in July and formed fruit. The fruiting peduncles were whitish with reddish blotches and bent over to submerge the fruits. By late August the flowers

and fruits were mostly senescent, but a new flowering cycle had begun on new stems. In September the new flowers were dominant and the previous cycle of fruits was almost gone. Many new green stems with red tips were formed. The marginal semi-terrestrial plants were still evident. The water level rose and temperatures dropped in October and many marginal semi-terrestrial plants reverted to normal morphology. No flowers and fruits were left but new green stems continued to be produced. In November the water level rose and flooded the last of the marginals and some more new green stems were formed. Through December and January no further changes were noted. In February the overwintering plants began to look brownish and senescent, very little new green growth was evident. This continued in March but some new growth of reddish buds and short stems became apparent. Little change occurred in April. The senescent, periphyton covered, old plants were covered in a mat of green, filamentous algae. In May new stems began to grow and reached the surface with young inflorescence buds by the end of the month. By the end of June the plants were in full growth, surfacing and in full flower.

QUEEN ELIZABETH PARK, POND #375, VANCOUVER

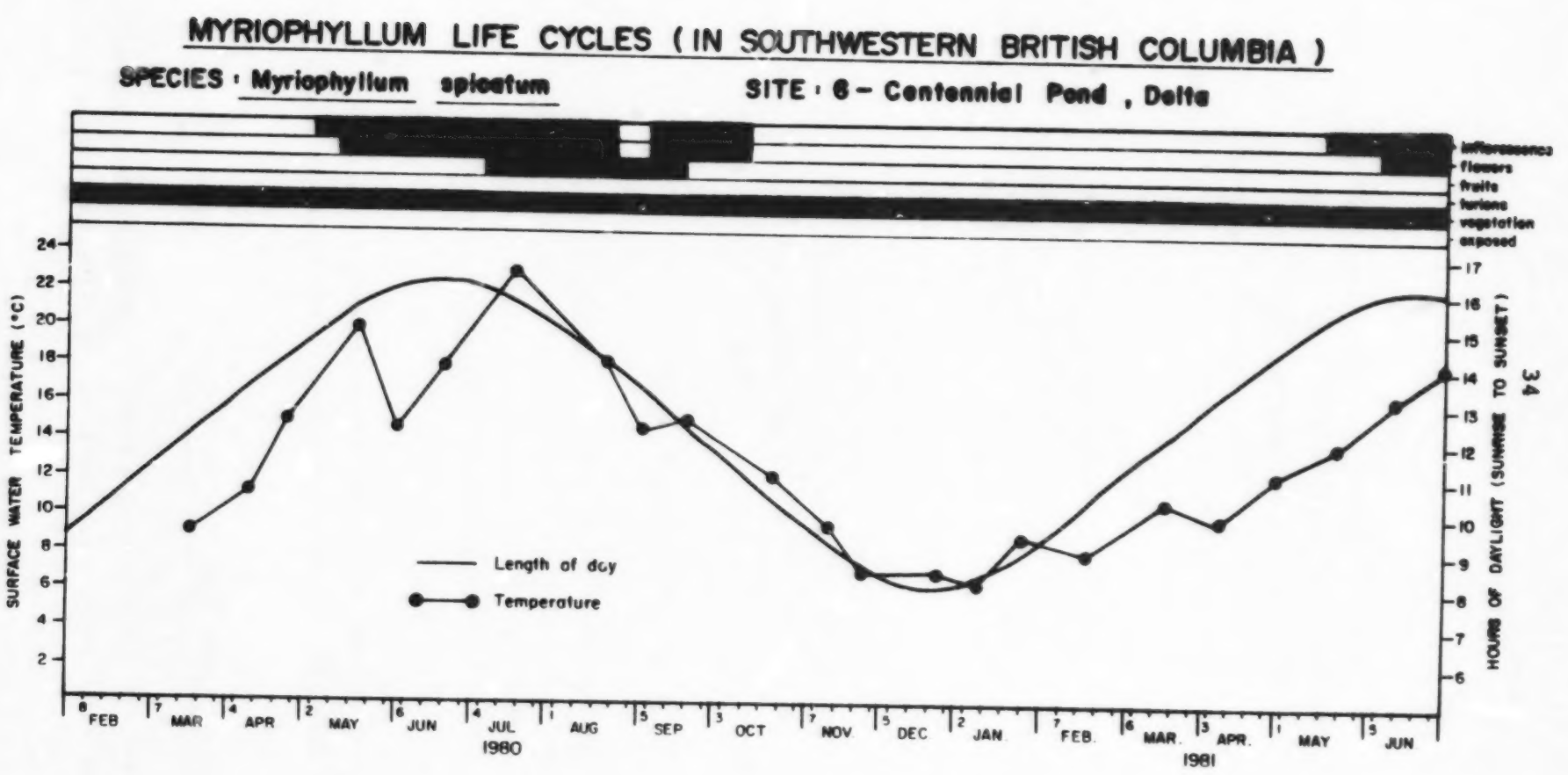
See the site description under M. heterophyllum. M. spicatum at this site has moved rapidly down the length of this pond and into the next pond. It is being followed down the pond, but at a much slower rate, by M. heterophyllum. Where the two meet M. heterophyllum outcompetes the M. spicatum and takes over most of the space.

The two species occupy the entire surface of the pond except for a small Nymphaea patch. The M. spicatum is the Fraser Valley morphological variant.

OBSERVATIONS - FEBRUARY 1980 TO JUNE 1981

In February there were no plants visible and in March and early April only a few small plants could be seen. By late April the plants were in

Figure 7


MYRIOPHYLLUM LIFE CYCLES ( IN SOUTHWESTERN BRITISH COLUMBIA )
SPECIES : Myriophyllum spicatum
SITE : 6 – Centennial Pond , Delta
inflorescence
flowers
fruits
turions
vegetation
exposed
SURFACE WATER TEMPERATURE (°C)
HOURS OF DAYLIGHT (SUNRISE TO SUNSET)
Length of day
Temperature
FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN
1980
1981

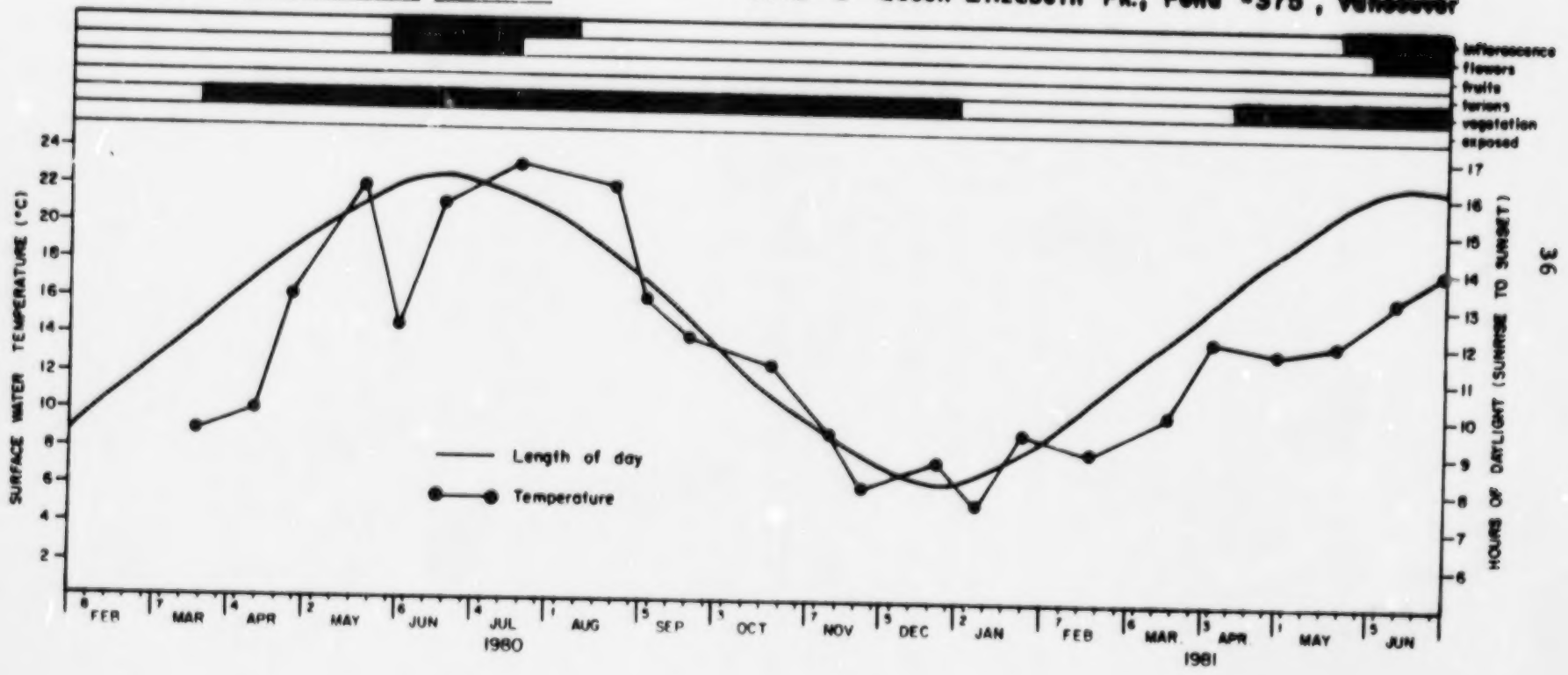
full vegetative growth with lots of branches and red tips but not yet surfacing. In May the plants surfaced and were growing actively, filling the pond but not yet flowering. During June both staminate and pistillate flowers opened. The plants were quite red. In late June senescence was beginning to be evident. In July the flowering finished; no fruits were formed. No new vegetative growth was seen and the old plants were mostly dying and rotting. During July the old plants continued to rot and a few fruits were still seen but many new green stems were growing from the roots. In September the old plants died completely and disappeared; no more flowers or fruits were left. The new shoots became reddish apically and more continued to form, they surfaced in dense mats in October and little change was seen in November or December except that no more new shoots were formed. In January all the tops of the plants died and only bare stems were left. Through February and March the plants remained dormant. In April the plants began to show new red-tipped vegetation but were not yet surfacing; by May the plants were surfacing, spreading over the surface and very red with young inflorescences. During June the plants came into full flower.

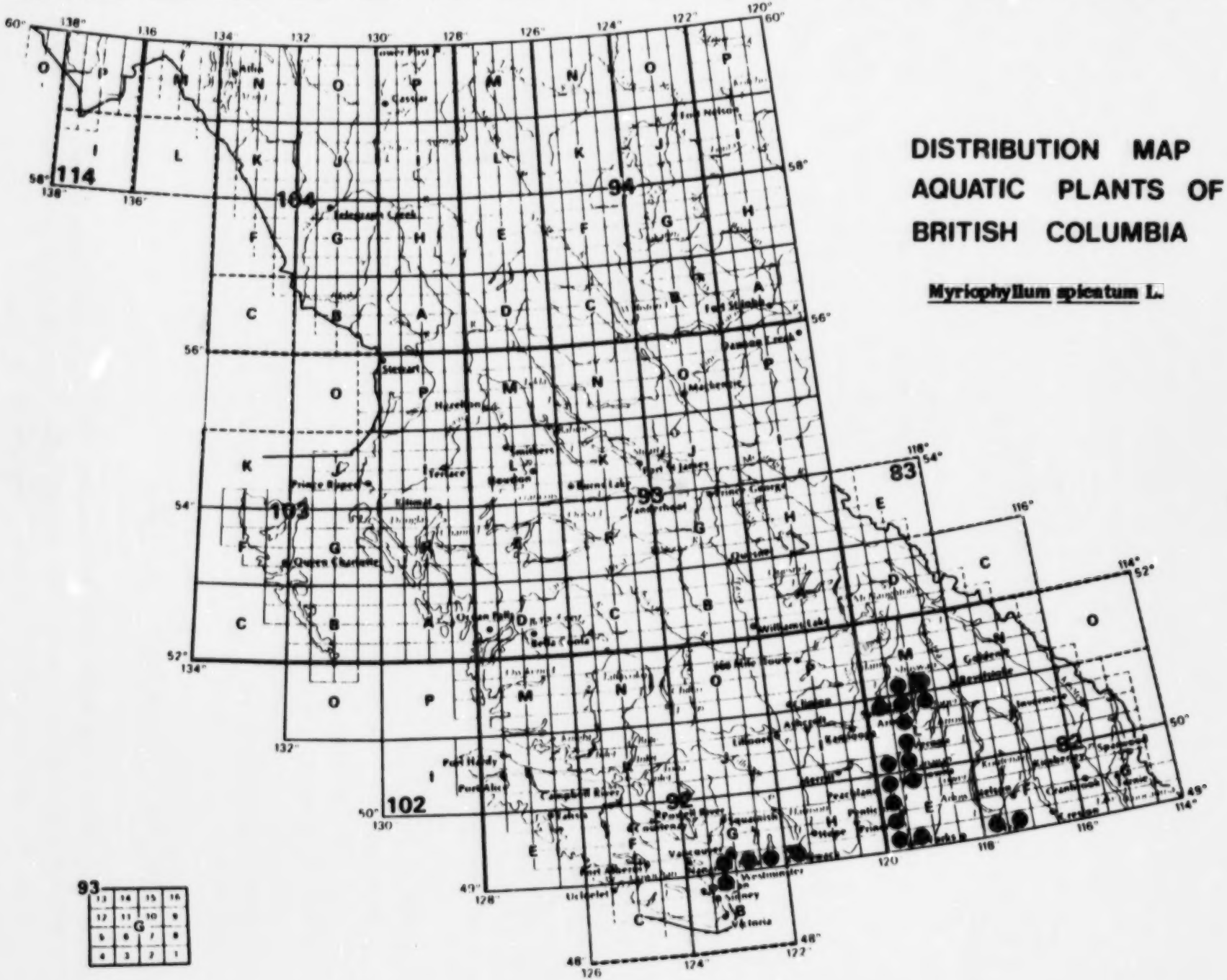
Figure 8

# MYRIOPHYLLUM LIFE CYCLES ( IN SOUTHWESTERN BRITISH COLUMBIA )

SPECIES : Myriophyllum spicatum

SITE : 8 - Queen Elizabeth Pk., Pond #375 , Vancouver




DISTRIBUTION MAP
AQUATIC PLANTS OF
BRITISH COLUMBIA
Myriophyllum spicatum L.
114
104
94
103
93
83
102
92
82
93

# CHAPTER 8
## M. ussuriense

The observation site for this species was lower Hatzic Slough, a shallow, muddy area at the south end of Hatzic Lake, downstream from the bridge to Hatzic Island but north of the highway and railroad embankment. The water level is controlled by gates for irrigation, drainage and recreation; levels fluctuate at least three metres. There are several emergent islands of Typha and grasses, narrow channels which usually remain submerged and large shallow muddy areas which are regularly exposed at low water in late summer to fall, and late winter to early spring. Myriophyllum ussuriense is found in very extensive beds on these mud flats and in a band around the islands. There is virtually no underwater visibility much of the year, due to a very high silt load.

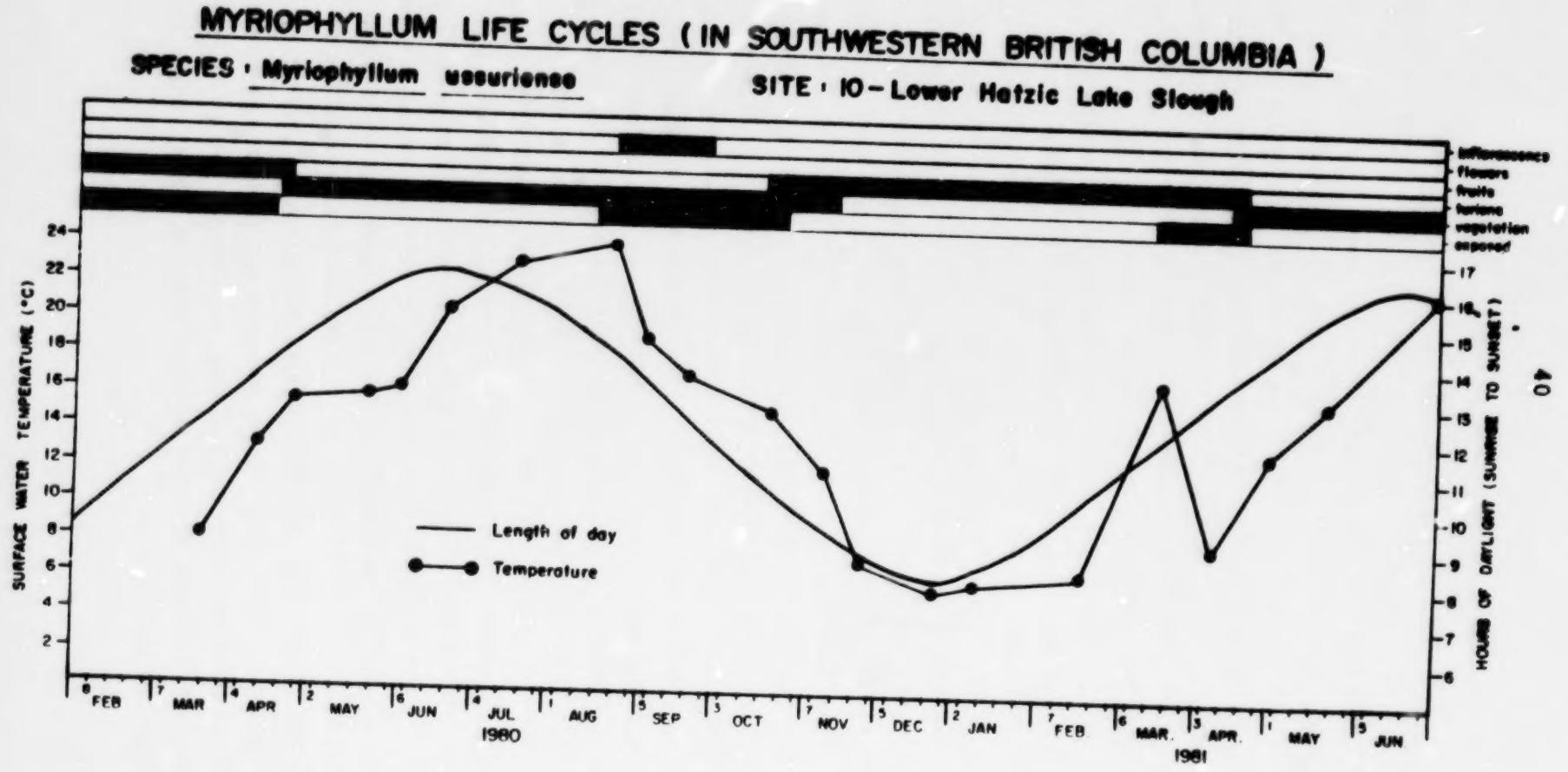
Myriophyllum ussuriense is extensively rhizomatous and exists beneath the mud over much of the slough; stems of several types are sent up from the rhizomes depending upon the season and the water level. At high water times in spring and summer it grows as a submerged plant with finely divided, typical Myriophyllum leaves on long thin stems. During low water levels when the beds are exposed in late summer and fall, the plants grow as a dense carpet of emergent plants to about 15 cm tall with small undivided to parted or pectinate leaves. This species has separate male and female plants; those in the observation area were all male but a few females are known from another part of this slough. Flowers are borne in the axils of upper leaves on the small emergent plants and not in specialized inflorescences.

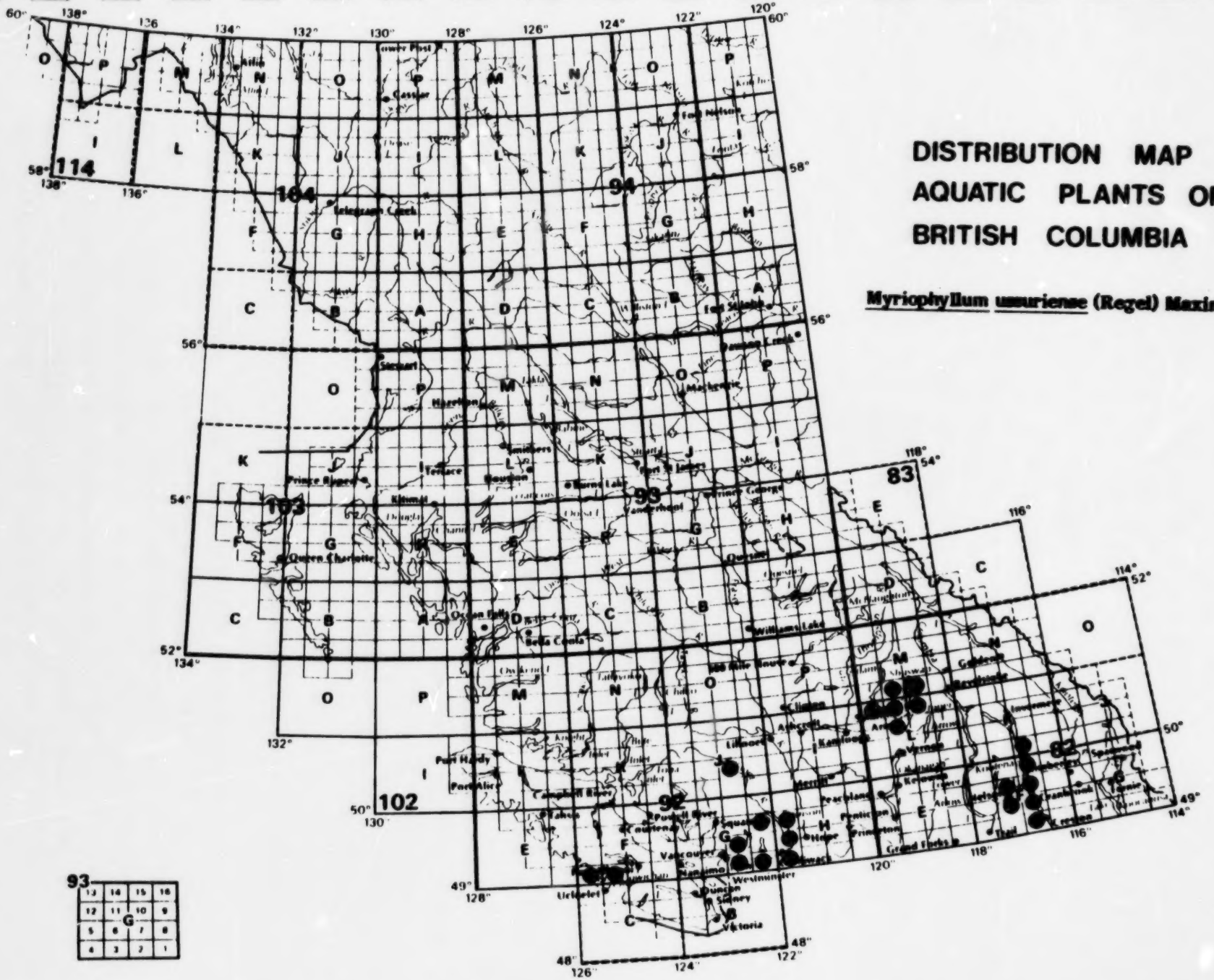
### OBSERVATIONS - FEBRUARY 1980 TO JUNE 1981

In February the water level was very low and the mud banks were exposed and subject to below freezing temperatures. The plants were dormant and in 'moss-like' appressed mats in a band along the perimeters of the islands;

turions were present on the stem apices. The water level rose to the edge of the Typha beds in March inundating most M. ussuriense sites and the 'moss-like' plants were all washed up on shore. In April the level was still up and new green stems were appearing on overwintering reddish mats along the waters edge and also from rhizomes and turions under water. By the end of April the water level was well up into the Typha zone and M. ussuriense was growing in the dissected leaf form under water. Carp and waterfowl had uprooted much of the bed and there were extensive mats of floating fragments on the surface. The plants continued to grow in this form under very dirty water at high levels through to the end of July. In August the water level dropped and some mud banks became exposed. On these banks the terrestrial form of M. ussuriense began to grow and on the plants exposed longest on the higher benches some male flowers appeared. Dissected-leaf plants still grew in submerged areas, and carp and geese were still creating floating mats of M. ussuriense fragments. By September the mud banks were fully exposed and covered in a carpet of terrestrial M. ussuriense plants in full flower with exposed stamens. Flowering lasted until the end of September, but vegetative growth continued through October, when small reddish turions appeared. The water level rose and covered all the M. ussuriense beds in November. Many fragments were found floating on the surface; these were mostly stems bare at the base with a few emergent-type leaves and turions at the apex. The submerged plants were mostly senescent or completely gone but there were a few green stems with small compact, red turions. From December to February no plants could be found, and dredging in the mud exposed only bare fragments of rhizomes in a dormant condition. These rhizomes were very fragile and did not hold togethr in clumps as they did in the summer and fall. In March and April a few plants were found growing from rhizomes or turions on exposed mud banks; these reached about 10 cm with undivided leaves before being covered by rising water at the end of the month. In May and June the plants grew as submerged forms under deep, dirty water which flooded several low lying houses and was two metres deep over the mud bank between the two islands where the main M. ussuriense bed exists.

Figure 9


MYRIOPHYLLUM LIFE CYCLES ( IN SOUTHWESTERN BRITISH COLUMBIA )
SPECIES : Myriophyllum ussuriense
SITE : 10 - Lower Hatzic Lake Slough
Inflorescence
Flowers
Fruits
Turions
vegetation
exposed
SURFACE WATER TEMPERATURE (°C)
HOURS OF DAYLIGHT (SUNRISE TO SUNSET)
Length of day
Temperature
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR.
APR.
MAY
JUN
1980
1981


DISTRIBUTION MAP
AQUATIC PLANTS OF
BRITISH COLUMBIA
Myriophyllum ussuriense (Regel) Maxim.
114
104
94
103
93
83
102
92
82
Telegraph Creek
Stewart
Terrace
Prince Rupert
Queen Charlotte
Ocean Falls
Bella Coola
Williams Lake
Quesnel
Prince George
Vanderhoof
Fort St James
Fort St John
Dawson Creek
Fort Nelson
Mackenzie
Smithers
Hazelton
Kitimat
Port Hardy
Campbell River
Courtenay
Nanaimo
Vancouver
Victoria
Westminster
Duncan
Sidney
Kamloops
Penticton
Princeton
Grand Forks
Trail
Kootenay
Arrow Lakes
Revelstoke
Golden
Lillooet
Ashcroft
Merritt
Hope
Squamish
Pemberton
Port Alice
Port Hardy
Atlin
Cassiar
Fort Nelson
Lower Post
Dease Lake
Liard River
Watson Lake
Fort Simpson
Fort Liard
Fort Providence
Fort Resolution
Fort Smith
Hay River
Yellowknife
Fort Rae
Fort Norman
Norman Wells
Fort Good Hope
Arctic Red River
Inuvik
Tuktoyaktuk
Aklavik
Old Crow
Whitehorse
Faro
Ross River
Watson Lake
Teslin
Carcross
Dawson
Mayo
Keno
Stewart
Beaver Creek
Haines Junction
Kluane Lake
Burwash Landing
Destruction Bay
Tok
Delta Junction
Fairbanks
Anchorage
Valdez
Cordova
Yakutat
Juneau
Petersburg
Wrangell
Ketchikan
Prince of Wales
Sitka
Kodiak
Homer
Kenai
Seward
Cook Inlet
Kuskokwim Bay
Bristol Bay
Nushagak Bay
Norton Sound
Kotzebue Sound
Chukchi Sea
Beaufort Sea
Amundsen Gulf
Coronation Gulf
Dease Strait
Queen Maud Gulf
Chesterfield Inlet
Baffin Island
Hudson Bay
Hudson Strait
Ungava Bay
Labrador
Newfoundland
Gulf of St Lawrence
Prince Edward Island
Nova Scotia
New Brunswick
Maine
Quebec
Ontario
Manitoba
Saskatchewan
Alberta
Montana
Idaho
Washington
Oregon
California
Nevada
Utah
Colorado
Wyoming
North Dakota
South Dakota
Nebraska
Kansas
Oklahoma
Texas
New Mexico
Arizona
Minnesota
Iowa
Missouri
Arkansas
Louisiana
Mississippi
Alabama
Georgia
Florida
South Carolina
North Carolina
Tennessee
Kentucky
Illinois
Indiana
Ohio
Michigan
Wisconsin
Pennsylvania
New York
Vermont
New Hampshire
Massachusetts
Rhode Island
Connecticut
New Jersey
Delaware
Maryland
Virginia
West Virginia
60°
58°
56°
54°
52°
50°
49°
48°
138°
136°
134°
132°
130°
128°
126°
124°
122°
120°
118°
116°
114°

# CHAPTER 9
# M. verticillatum

The observations on M. verticillatum were made in Marble Bay, Cowichan Lake. The site is at the east end of the lake, in a small isolated bay which is well protected from wind and wave action. The angle at which the bay opens into the main lake and the shallow sill at the mouth also isolate the bay from the main body of water in the lake and the rapid temperature fluctuations which occur at peak run-off times. The end of the bay is in a fairly natural state and borders on the University of Victoria field station; it is forested and lined by willows on the banks. Potamogeton robbinsii covers most of the shallow muddy bottom. M. verticillatum grows primarily along the forested south sith of the bay where it does not get any sunshine until late in the morning.

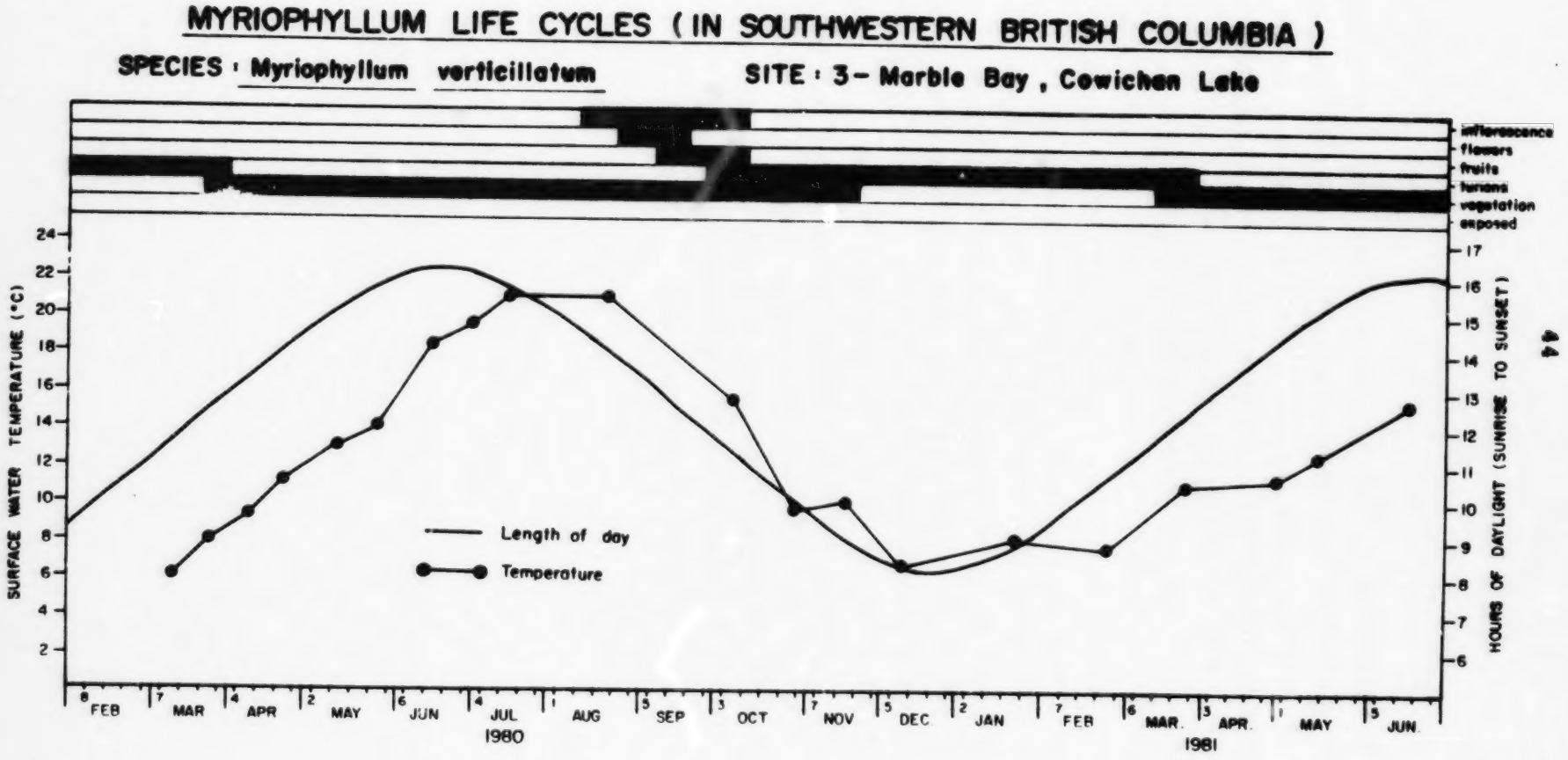
M. verticillatum is a native B.C. species and is both widespread and common in the province. The plant forms turions as early as mid-August and overwinters in this form; all vegetative parts die and rot by winter, thus all the new growth in the spring is from elongating turions. This species has distinctive emergent inflorescences, from the apices of the stems, which bear female flowers first, below, and male flowers later, above. Fruit formation is commonly observed unless rising water levels submerge the flowers too soon.

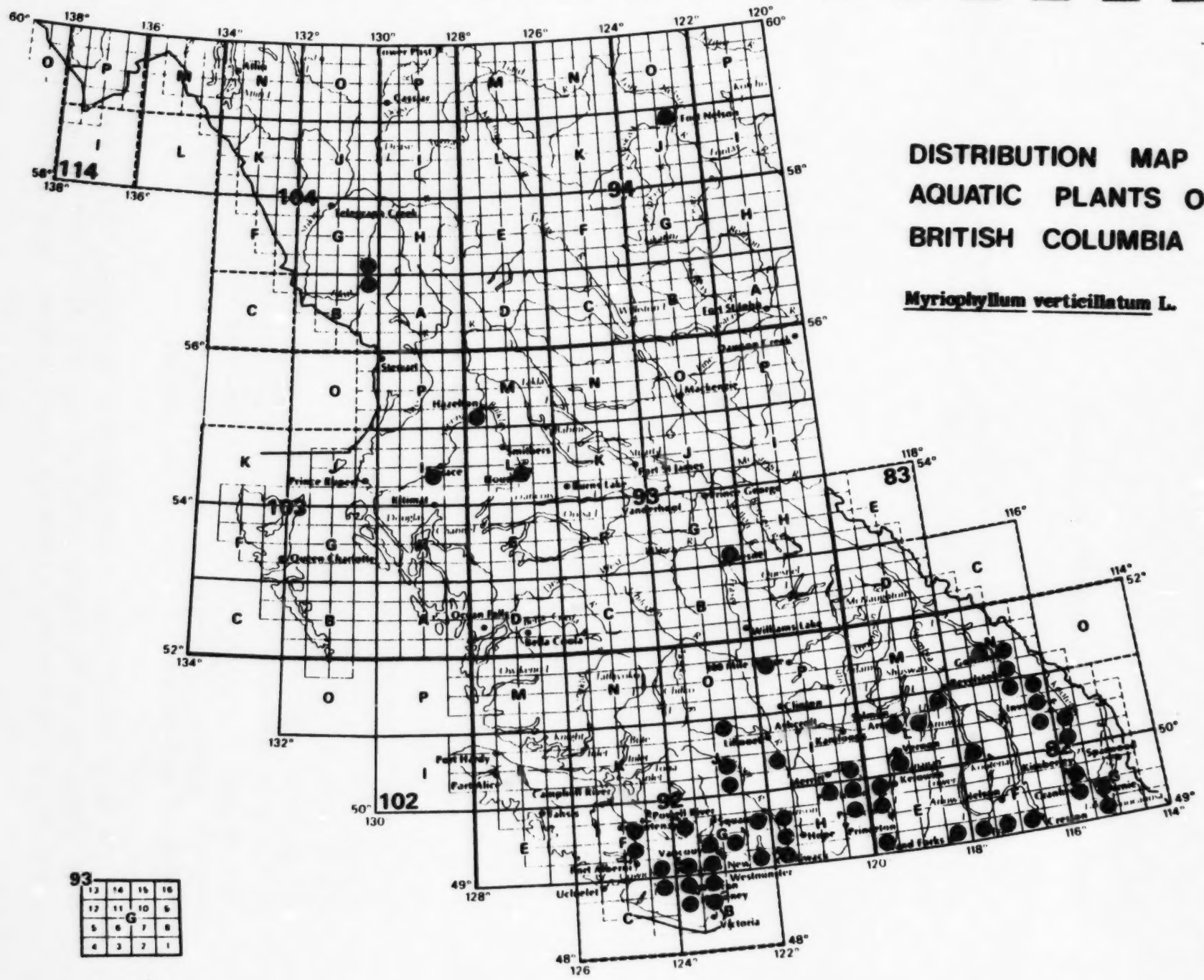
## OBSERVATIONS - FEBRUARY 1980 TO JUNE 1981

Through February and March the plants were still dormant in the turion stage and only began to elongate in April or very late March as the water level dropped and temperatures rose to about 9°C. During April the turions elongated to at least 25 cm long, formed adventitious roots and became anchored in the sediment and erect. Vegetative growth occurred in May to form very dense, extensive beds of M. verticillatum but they did not surface. In June and July the plants grew even thicker and bushier with

bright green apices but did not surface until late July or early August. In August female and male flowers appeared on the emergent inflorescences. In September fruits formed and the plants remained green and active but some apices began to form turions. The water level dropped very low in October and parts of the M. verticillatum bed were exposed and dry. The submerged plants were still green and growing but had lateral and terminal turions, up to five per plant, still attached. Some of these turions were negatively buoyant but many still floated. Temperatures dropped rapidly in October. In November the water level rose rapidly and shallow plants disintegrated leaving only turions; deep water plants remained green at the apices but showed senescence below. Little change occurred in December but in January most old plants had died and rotted, only a few stems with turions attached remained. Some of these attached turions had elongated and were up to 25 cm long and bright green; no detached turions were growing. In February and early March no plants were found, only turions. In early March some turions were beginning to expand and adventitious roots were forming. By the end of April all turions had elongated to at least 25 cm, were rooted in the sediment, and erect with some new leaves and elongate internodes. In May and June the plants grew vigorously but did not surface or form inflorescence buds.

Figure 10


MYRIOPHYLLUM LIFE CYCLES ( IN SOUTHWESTERN BRITISH COLUMBIA )
SPECIES : Myriophyllum verticillatum
SITE : 3 - Marble Bay , Cowichan Lake
inflorescence
flowers
fruits
turions
vegetation
exposed
SURFACE WATER TEMPERATURE (°C)
HOURS OF DAYLIGHT (SUNRISE TO SUNSET)
Length of day
Temperature
FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN
1980
1981


DISTRIBUTION MAP
AQUATIC PLANTS OF
BRITISH COLUMBIA
Myriophyllum verticillatum L.
114
104
94
103
93
83
102
92
82
Fort Nelson
Fort St. John
Dawson Creek
Prince George
Prince Rupert
Queen Charlotte
Williams Lake
Kamloops
Kelowna
Vancouver
Victoria
Westminster
Campbell River
Port Alberni
Port Hardy
Ucluelet
93
G

## OBSERVATIONS AND CONCLUSIONS

The growth cycles reported represent only the year of sampling and will certainly vary from year to year depending upon the weather. It would be necessary to carry out several successive years of such sampling to get average results and determine more accurately the typical or general response of the species at a given site.

Water temperatures in the small ponds are obviously a fairly direct function of insolation and follow the theoretical daylength curve very well. The temperatures would probably more accurately reflect a plot of actual hours of sunlight after cloudy periods were subtracted. While such data are available for weather stations they are very site specific and generally not available for most sites.

The sampling frequency was too low, or poorly timed in some cases, to determine exactly when certain activities started or stopped but generally timing was not out by more than two weeks.

We know very little about the critical environmental parameters affecting the growth of Myriophyllum spp. (or any other aquatic plant) particularly the nutrient requirements and sediment preferences. This lack of data severely restricts our ability to predict where, when or if a species may grow or become a nuisance. It has been observed that some species of Myriophyllum always grow in conjunction with other species of the same genus, while some species never are associated with other Myriophyllum species. This may well be significant information in predicting the potential for growth of Myriophyllum species in certain sites, but more comprehensive studies and adequate nutrient information are required.

The yearly growth cycles of some species of Myriophyllum in B.C. are quite complex and poorly understood and yet are very significant in any control program, particularly a biological control program. More detailed

and long term studies are required before we can predict growth responses to certain variables. Most of the apparently non-native or recently introduced species do not have a specific overwintering mechanism (such as turions) and tend to remain green and active all winter. This means they do not relinquish their occupancy of the site at any time and have a competitive edge for light and space in the spring. Of these species M. heterophyllum, M. hippuroides M. elatinoides, M. spicatum and, in warmer climates, M. brasiliense are nuisances or potential nuisances.

M. heterophyllum is outcompeting M. spicatum under the conditions found in pond #375 in Queen Elizabeth Park in Vancouver. M. spicatum has spread down the pond and into the next pond, #403, very much faster than M. heterophyllum could follow but as M. heterophyllum spreads down into an M. spicatum occupied site it permanently establishes itself and gradually displaces M. spicatum. In pond #375, M. heterophyllum has significant green vegetative biomass on the site all year, whereas M. spicatum dies off to dormant root-crowns for about three months in late winter and early spring.

The subtropical species M. brasiliense could become naturalized in southwestern B.C. but is not likely to become a major nuisance, due to the relatively low average water temperature in B.C. The plant is presently under cultivation in an outdoor pond in the Park and Tilford Gardens and has survived freezing conditions for at least four years. It stays green and active all winter. The only attention it appears to receive is pruning in the spring.

As mentioned above, M. spicatum in Queen Elizabeth Park is dormant for several months in the winter but in Centennial Pond the species is evergreen, though growth slows in late spring when a heavy algal bloom covers the pond.

M. spicatum, M. hippuroides, M. heterophyllum, M. elatinoides, and to a lesser extent, M. farwellii have several cycles of vegetative growth throughout the year. Thus, though there is green vegetative biomass present

all year it is not the same stems and leaves all the time; there is a continuous loss of older leaves and stems and growth of new ones from the rhizomes, root crowns, basal lateral buds and horizontal stems. These plants thus maintain their tenancy of a site all year and outcompete other more seasonal species. The timing and type of control measure to manage these populations effectively is quite critical. It is pointless and uneconomic to remove vegetation which will shortly die off naturally; it is better to wait and catch the beginning of the next cycle of growth.

Myriophyllum species in British Columbia fall into several groups based on their life cycles:

The first group consists of two well-established, native species with wide distributions, which form turions in the fall and have little if any overwintering vegetation in most parts of B.C. They are dormant in the winter as turions and reestablish themselves in a site from turions each spring. This group includes M. verticillatum and M. exalbescens. There is only one cycle of vegetative growth in a season.

A second group contains species which are introduced to B.C. and do not have turions. Except for M. spicatum they are from warmer climates and not adapted to a dormant season, thus they have considerable vegetative growth on their sites all year. The species are M. elatinoides, M. brasiliense and, in some very mild coastal sites, M. spicatum. M. elatinoides is rhizomatous and the other two are perennial from a root crown or caudex. They have several cycles of vegetative growth in a season.

M. hippuroides, M. heterophyllum and M. spicatum form a third group. They are all north temperate species but do not form turions. Under mild conditions they maintain green, active, vegetation on the site all year but under more severe conditions or a cold spring they may die back to the caudex or root crown for a brief period before beginning growth again. They have several cycles of vegetative growth, which usually overlap each other, throughout the year, so that there is always some vegetation on the site.

The other two species are unique. M. farwellii has turions which generally stay on the plant almost all year and there is green, vegetative growth on the site all year. The germination of turions occurs before the old plants die and old vegetation usually loses leaves and reclines on the bottom where roots form and new shoots arise in the spring. Possibly in more severe winter conditions the vegetation would not survive the winter and this species would fall into group one.

M. ussuriense also has turions but is perennial from rhizomes. Due to its very specific site requirements and water level regime it is not found in an active vegetative state all year but goes dormant where water is too deep or the site is exposed in winter. There are two distinctive types of vegetation; the dissected-leaf type in submerged conditions and the entire-leaf type when exposed; as water levels drop there is a change from the dissected to the entire form.

TABLE 3

REPRODUCTIVE AND OVERWINTERING MECHANISMS OF *Myriophyllum* IN B.C.

| | SEEDS | TURIONS | CAUDEX | EVERGREEN | RHIZOMES |
|---|---|---|---|---|---|
| Group 1 (Native | | | | | |
| *M. exalbescens* | yes | yes | no | no | no |
| *M. verticillatum* | yes | yes | no | no | no |
| Group 2 (Introduced) | | | | | |
| *M. elatinoides* | yes | no | yes | yes | yes |
| *M. brasiliense* | no | no | yes | yes | no |
| *M. spicatum* | yes | no | yes | maybe | yes |
| Group 3 (Introduced) | | | | | |
| *M. hippuroides* | rare | no | yes | usually | no |
| *M. heterophyllum* | rare | no | yes | yes | no |
| *M. spicatum* | yes | no | yes | maybe | yes |
| (Status unclear) | | | | | |
| *M. farwellii* | yes | yes | yes | yes | no |
| *M. ussuriense* | yes | yes | no | no | yes |

## RECOMMENDATIONS

This limited introductory study only indicates the growth responses in a single year. To determine how typical that year was, and whether or not growth responses are uniform to given environmental variables, the study would have to be continued for a number of years. Only then could some measure of the variability in the timing of growth responses be determined.

This study was confined to the two Biogeoclimatic Zones of Krajina which have the mildest winters and is not indicative of climatic conditions in the remaining nine zones which permit some species of Myriophyllum to grow. The timing of various growth responses and nature of the overwintering mechanism will vary with the zone in which the plants grow, and will need to be determined for each zone separately.

If management of different species of Myriophyllum throughout the Province is contemplated, then a more comprehensive study of the yearly growth cycles over several years and in different zones is required. This would allow us to predict the normal growth response for each species in each zone where it is found, to determine at what time to apply various control programs and to separate treatment effects from normal yearly variation.

POOR

QUALITY

ORIGINAL